AAMRL-TR-90-014

USER'S GUIDE FOR CREW CHIEF: A COMPUTER GRAPHICS SIMULATION OF AN AIRCRAFT MAINTENANCE TECHNICIAN (VERSION 2 - CD21)

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MARCH 1990

PERIOD OF PERFORMANCE: SEPTEMBER 1987 TO NOVEMBER 1989

Approved for public release; distribution unlimited

ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY
AIR FORCE HUMAN RESOURCES LABORATORY
HUMAN SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433

NOTICES

TECHNICAL REVIEW AND APPROVAL

AAMRL-TR-90-014

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

The voluntary informed consent of the subjects used in this research was obtained as required by Air Force Regulation 169-3.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

CHARLES BATES, JR.
Director, Human Engineering Division
Armstrong Aerospace Medical Research Laboratory

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
20 November 1989

3. REPORT TYPE AND DATES COVERED
Interim Technical Report/Sept 87-Nov 89

4. TITLE AND SUBTITLE
USER'S GUIDE FOR CREW CHIEF: A COMPUTER GRAPHICS SIMULATION OF AN AIRCRAFT MAINTENANCE TECHNICIAN (VERSION 2 - CD21)

5. FUNDING NUMBERS
C. F33615-84-C-0519
PE. 62202F
PR. 7184
TA. 08
WU. 41

6. AUTHOR(S)
Korna, M., Krauskopf, P., Haddox, D., Hardyal, S., Jones, M., Polzinetti, J., and McDaniel, J. (AAMRL)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
University of Dayton Research Institute
300 College Park Avenue
Dayton, Ohio 45469-0001

8. PERFORMING ORGANIZATION REPORT NUMBER
UDR-TR-89-107

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Aerospace Medical Research Laboratory and
Air Force Human Resources Laboratory
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio 45433

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AAMRL-TR-90-014

11. SUPPLEMENTARY NOTES
Computer graphics aided design and Manufacturing

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This user's guide describes the procedures for using the CREW CHIEF system of Computer programs. The CREW CHIEF system of programs is a computer graphics simulation of the physical characteristics and capabilities of Air Force maintenance technicians. The system as it now exists operates interactively with the CADAM software package. The user should be knowledgeable in CADAM operations, as CADAM interactions are not included in this document.

The guide includes an introduction to the technician model and the conventions used to develop and analyze the interactions of the man-model's physical characteristics and capabilities with the elements of the work station.

CADAM is a registered trademark of CADAM, Inc., 1935 Buena Vista St., Burbank, California 91504. Use of this term does not constitute an endorsement of the CADAM system. Keywords

14. SUBJECT TERMS Three-dimensional anthropometric man-model, Aircraft design, Computer simulation, Aircraft maintainability, Aircraft maintenance tools evaluation, Aircraft maintenance technician, (KR)

15. NUMBER OF PAGES
397

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

Standard Form 298

SUMMARY

This User's Guide describes the procedures to operate the Harry G. Armstrong Aerospace Medical Research Laboratory's and the Air Force Human Resources Laboratory's CREW CHIEF system of programs. The CREW CHIEF system of programs is interactive with the CADAM* (Computer-graphics Aided Design And Manufacturing) software package, and therefore it is necessary that operators be qualified in the use of CADAM, as this document does not duplicate the CADAM operating instructions. CADAM's interface with the CREW CHIEF system of programs does not constitute an endorsement of the CADAM system by the U.S. Air Force or its contractors.

The CREW CHIEF system of programs provides for designers a tool for early identification of design-related maintainability problems by analyzing the interaction of maintenance technicians' physical capabilities and the design elements related to specific maintenance tasks. Historically, many of such maintainability problems have been found when the system design prevents timely and cost-efficient corrective action. Such problems are often passed to the logisticians to correct, or to endure, after the system has been delivered. Since maintenance accounts for approximately 35 percent of the total cost of a system during its years of use, early identification and correction of design-induced maintenance problems can result in significant cost savings.

The CREW CHIEF program is not intended to provide solutions for all problems. For example, current military standards provide guidelines for locating components for ease of access-ibility based upon such factors as frequency of

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maintenance actions required and the criticality of the sub-system concerned. Due to space constraints, the possible locations of sub-system components may be limited. The CREW CHIEF program will not create designs, but will allow the designer to evaluate the maintainability of a candidate design. The program will also allow the user to analyze the interaction of a maintenance technician with a system design, and will enable the user to evaluate limitations and capabilities in three main areas: physical accessibility, strength, and visibility.

PREFACE

This work was performed by the University of Dayton, 300 College Park, Dayton, Ohio 45469, under United States Air Force Contract F33615-84-C-0519, entitled "Techniques for Workplace and Maintenance Evaluation." The government work unit number for this contract is 71840831. Dr. J. W. McDaniel, of the Armstrong Aerospace Medical Research Laboratory's Workload Ergonomics Branch (AAMRL/HEG), is the contract monitor. The contract was jointly funded and managed by the Armstrong Aerospace Medical Research Laboratory and the Air Force Human Resources Laboratory.

The purpose of the report is to provide a detailed guide for the user to operate the CADAM* version of the CREW CHIEF program. It does not document the theoretical approaches used in developing the programs. The introduction of the report (Section 1) gives general background of the concepts and development of the programs. Sections 2 through 7 provide details for using the CREW CHIEF programs, and Section 8 is a Quick Reference section for the seasoned user.

The authors would like to thank the following University of Dayton Research Institute (UDRI) staff members for their contributions: John Quinn, William Stump, Nilda Martinez, Glenn Robbins, Van Thai, Liem Lu, James Reis, and Kevin Maute.

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GLOSSARY OF TERMINOLOGY

Access Function Key	CADAM supplied program which allows user to access their own programs
Action	A description of the user's objective and necessary input to operate the program.
Azimuth	A horizontal direction of a point from a reference point measured from 0° at the reference direction clockwise through 360°.
Body Size	The 1st, 5th, 50th, 95th, and 99th percentiles for both male and female, based on the Air Force maintenance technician population.
Connector	A device used on aircraft to mate parts to the electrical system or to provide attach/detach points in long electrical cables to accommodate maintenance. They typically have male and female components held together by lock rings.
CREW CHIEF	The system of computer programs entitled CREW CHIEF.
Crew Chief	The man-model generated by the CREW CHIEF system of programs.
Default Value	Any value initially set by the CREW CHIEF system of programs.
Drawing	Any user-generated display.
Elevation Angle	Angle from some object in the work space to the line of sight.
Enfleshment	The exterior mesh that represents the muscles and tissues of the man-model and also represents his/her clothing.
Ergonomics	Scientific study of the relationship between man and his working environment.
Example	One of several possible actions chosen to illustrate a particular function.

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Front Display	One of four types of display for the man-model; the front half of the wire-frame man-model as viewed from the designer's location at the graphics scope; display contains less clutter than the full wire-frame model, but can be used for limited visual interference.
Head Point of Vector	The point of application of a tool or connector.
Interactive	Immediate response to input. In interactive processing, an image can be modified or edited and the changes seen right away, as contrasted to "batch" processing in which the user must wait for results.
Key in	To input user-specified information via a keyboard.
Man-Model	Software-generated technician as he/she appears on the screen.
Mechanical Work	The product of force and displacement.
Obstacle Avoidance	Check during a Reach Analysis to ensure that a man-model can perform a task with no interference between the workstation and the man-model's arms.
Percentile	A value in the range of a set of data which separates the range into two groups so that a given percentage of the measures lies below this value.
Platform	The surface which supports the man-model's body.
Point of Attachment	The point to which the man-model attaches a tool.
Position Reference Point	The posture-dependent point on the man-model which lies in the same plane as the platform.

Profile Display	One of four types of display for the man-model; a profile view of the man-model as seen from the designer's viewpoint at the graphics scope; the least cluttered of displays, and provides a two-dimensional display suitable for "finished" plots.
Prompt	A short phrase on screen which cues the user's actions.
Rectilinear	Consisting of or bounded by lines.
Reposition Display	One of four types of display for the man-model; this display is chosen when the intent is to manually reposition the man-model; similar to the three-dimensional wire-frame model, but includes extra dashed lines to aid in the repositioning process.
Result	Subsequent system response to a user's input.
Screen	Another name for cathode ray tube (CRT)
Select	To choose a menu item or an element from a screen.
Shelf	The surface onto which an object is lifted.
Strength, Dynamic	A measurement of strength with motion resulting in force or torque and also resulting in mechanical work.
Strength, Static	A measurement of strength without motion resulting in force or torque but not resulting in mechanical work.
Tail Point of Vector	The line defined by this point and the head point determines from which direction the tool will be applied.
Window	The illuminated area of a CRT

Wire Frame Display	One of four types of display for the man-model; a three-dimensional wire frame figure which may be rotated and moved using the appropriate CADAM Window (PFK 27) Functions; a type of enfleshment which may be used for visually identifying potential areas of interference between the man-model and the workplace design.
Workplace	Any drawing which represents the man-model's task area.

LIST OF ABBREVIATIONS

AAMRL	Armstrong Aerospace Medical Research Laboratory
AAMRL/HEG	Armstrong Aerospace Medical Research Laboratory's Workload and Ergonomics Branch
AFHRL	Air Force Human Resources Laboratory
AFR	Air Force Regulation
AFSC	Air Force Specialty Codes
ANKB	Alphanumeric Keyboard
CAD	Computer Aided Design
CADAM*	Computer-graphics Aided Design and Manufacturing
<CR>	Carriage Return
IUE	Interactive User Entry
LOS	Line-of-Sight
LRU	Line Replaceable Units
N/A	Not Applicable
PFK	Program Function Keyboard
UDRI	University of Dayton Research Institute
WPAFB	Wright-Patterson Air Force Base
2-D	Two-dimensional
3-D	Three-dimensional

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LIST OF FUNCTIONS

CREW CHIEF Main Programs Menu

CREW CHIEF Generation Function

CREW CHIEF Initialization Function

CREW CHIEF Regeneration Function

CREW CHIEF Manual Repositioning Function

CREW CHIEF Head Orientation Function

CREW CHIEF Task Analysis Function

Tool Analysis Function

Materials Handling Analysis Function

CREW CHIEF Carry Function

CREW CHIEF Hold Function

CREW CHIEF Lift Function

CREW CHIEF Pull Function

CREW CHIEF Push Function

CREW CHIEF Reach Function

Connector Analysis Function

Visibility Analysis Function

CREW CHIEF Accessibility Function

Interference Analysis Function

Work Envelope Analysis

Current CREW CHIEF Data Function

SECTION 1
INTRODUCTION

Approximately 35 percent of the life-time cost of a military system is spent to maintain the system. Much of this cost can be avoided if, during the system's developmental stage, the interaction between the maintenance technician and the system design can be analyzed. Past practice has been to make these analyses by visual inspection of engineering drawings and detailed mock-ups of the system. The mock-up, using real people to analyze the interaction, has been the most beneficial method of identifying maintainability problems. The major problem with using mock-ups is that the design must be at a mature stage before a mock-up can be constructed. When the system is at a mature stage, changes to improve maintainability are often not made because of the costs and time delays involved in design change, modification of the mock-up, and the re-analysis of the technician and mock-up interactions.

Computer Aided Design (CAD) systems and computer models which graphically portray human physical characteristics and capabilities have reached the stage where it is possible to assess the interactions of systems and technicians at early stages of design development. The earliest possible identification of maintainability problems due to the poor interaction of the system and the technician should help reduce the life-time maintenance cost of a system. Thus, the concept and development of CREW CHIEF is a logical step in the early identification of maintainability problems. The CREW CHIEF system of programs is interfaced directly with the CAD data base, allowing the designer to evaluate three human factor areas against drawings in that CAD data base. This capability allows early identification of maintainability problems and reduces, and may eventually eliminate, the requirement for mock-ups.

Maintainability problems, as related to human factors, generally fall into three areas: Physical Accessibility, Strength, and Visibility. In the development of the CREW CHIEF system of programs, the following definitions of these human factors were used.

1. Physical accessibility: the interaction of body size, technician posture, tool size and working envelopes, location of the task object relative to adjacent or interfering components or structures, and task analysis.

2. Strength: the technician's ability to apply a specified torque, and/or to lift, position, lower, or remove an object to/from a design-specified location from the posture dictated by the working environment.

3. Visibility: the field of view of the technician relative to technician posture, location of the task object, and components and structures that may partially or wholly obscure the task location.

A maintainability problem may involve combinations of these three human factors. For example, a lack of visibility may aggravate a physical accessibility problem by making it more difficult to properly align and position a tool in a restricted working area.

Current military standards establish guidelines for placement of components for accessibility, based on such factors as item size, frequency of maintenance and/or failure, and criticality to system operation. Although the CREW CHIEF system of programs will not resolve the designer's dilemma in such areas, its ability to analyze alternative designs in the interest of maintainability can provide realistic data for design decisions.

1.1 SYSTEM REQUIREMENTS

The CREW CHIEF system of programs is designed to interact with a few popular CAD/CAM software packages and their data bases. Therefore, CREW CHIEF runs on the same hardware used to run the CAD/CAM software. The version of CREW CHIEF described in the manual runs under software package CADAM*, Version 21.0.1, and requires the user to have both the 3-D Interactive Design and Manufacturing Module and the ACCESS Module.

The CREW CHIEF system of programs is interfaced directly to the CADAM software [through Interactive User Exit (IUE)], and follows very closely the nomenclature and user interface methods employed by CADAM. Thus minimal training time is required for the experienced CADAM user to learn to use the CREW CHIEF program.

NOTE:

CADAM's interface with the CREW CHIEF system of programs does not constitute an endorsement of the CADAM system by the U.S. Air Force or its contractors.

*CADAM is a registered trademark of CADAM, Inc., 1935 N. Buena Vista St., Burbank, CA 91504.

The CREW CHIEF program was developed with the main menu under the IUE program. The CREW CHIEF program is currently contained in its own IUE PGM DIRECTORY (IUE Program Directory) and will need to be accessed accordingly. This is done to ensure that your own IUE Program Directory is not modified. See CREW CHIEF Installation for more details.

It is recommended that the version of CADAM being used with CREW CHIEF have its model size set to the maximum (32K), as some of the program's graphic representations require a significant amount of drawing space (8-10K). The maximum REGION size should be set to 2000K, due to CADAM's program structure.

When running CREW CHIEF, the use of a single scope version of CADAM is recommended, since all scopes in a particular region are "locked out" while a IUE program, hereinafter referred to simply as "function," is executing. Executing in a multiple-scope environment will result in loss of productivity by all users in the region. CADAM instructions have the information necessary to set up a single-scope version of CADAM.

1.2 MAN-MODEL GENERATION

To prevent corrupting the design drawing with unnecessary geometry, the man-model is not automatically made a part of the designer's drawing upon generation. All pertinent information concerning the man-model is automatically written to FORTRAN files and accessed when performing analyses. If the user desires to have the man-model display as a part of the drawing for future reference, he/she must "SAVE" the geometry with CADAM procedures after the function has run.

1.3 WORKPLACE DESIGN

The CREW CHIEF system of programs assumes that workplaces consist of valid 3-D CADAM drawing elements. These include, but are not limited to 3-D lines, splines, points, and surfaces. CADAM's MESH geometry are not processed by CREW CHIEF.

The length of execution time required for analysis depends on the size of the drawing on which the analysis is being done. Execution time can be minimized by "NO-SHOWING" CADAM elements that are outside the immediate work area of the CREW CHIEF man-model. This allows the program to bypass the processing of irrelevant data, e.g., when performing an Interference Analysis, the user can NO-SHOW those CADAM elements that clearly do not interfere with the man-model.

Since IUE programs can process more than one drawing, analysis of overlaid drawings will be performed only on the active drawing. Thus the user may need to change the active drawing if he/she wishes to analyze geometry contained in a non-active member of an overlay. The CREW CHIEF model will be placed in a overlay if the user so indicates during the execution of a CREW CHIEF function.

1.4 THE CREW CHIEF MAINTENANCE ANALYSIS PROGRAMS

The CREW CHIEF Main Programs consist of five distinct functions: Generation, Maintenance Task Analysis, Visibility Analysis, Accessibility Analysis, and the Current CREW CHIEF Data (Configuration) (Figure 1.1).

The user must be in a CADAM group and user that contains the drawings OVERLAY, TEMP MAN-MODEL, WORKPLACE SAVED, and ACTIVE. These drawings need not have anything in them initially, but need to be created to ensure the proper execution of CREW CHIEF (see the CREW CHIEF Installation Guide for more details).

The first step in performing any analysis under CREW CHIEF is to retrieve a CADAM 3-D drawing containing the design to be analyzed. Once the drawing has been retrieved, the user proceeds to the CREW CHIEF system of programs by depressing the ACCESS function key (PFK 11) (Figure 1.2.). Depressing ACCESS calls the ACCESS main menu. The CREW CHIEF Main menu is accessed by selected /EXECUTE IUE PGM/ and then selecting 3D INTERACTIVE PROGRAMS under the heading CADAM-SUPPLIED IUE APPLICATION PROGRAMS. The 3D APPLICATION PROGRAM menu appears and the CREW CHIEF application program can be selected from the bottom middle selection.

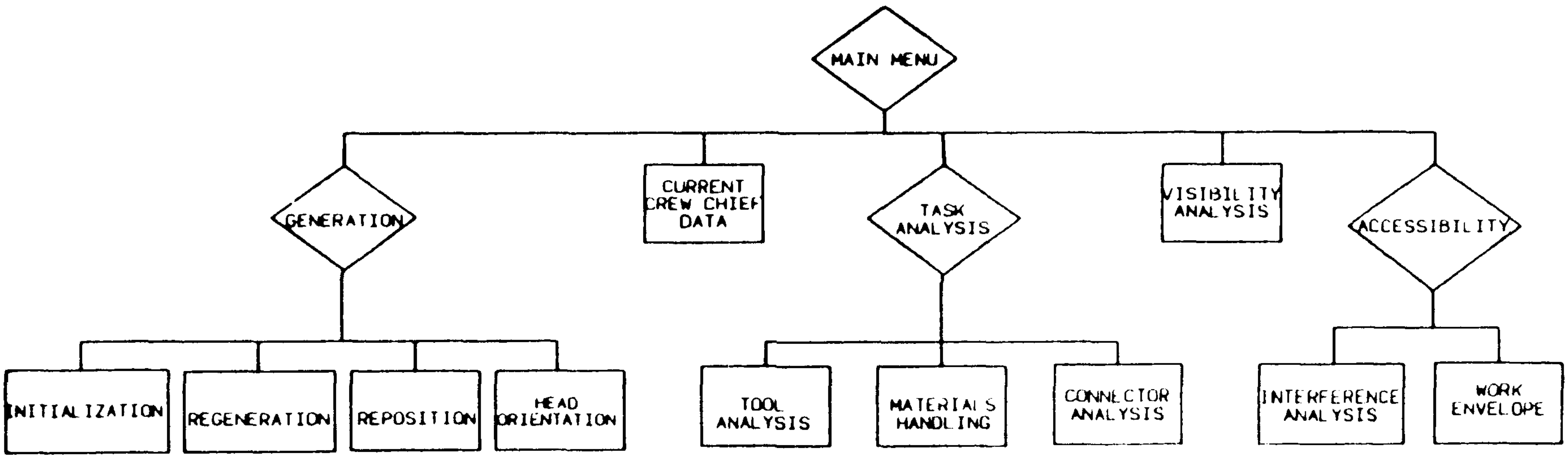


Figure 1.1. CREW CHIEF Programs.

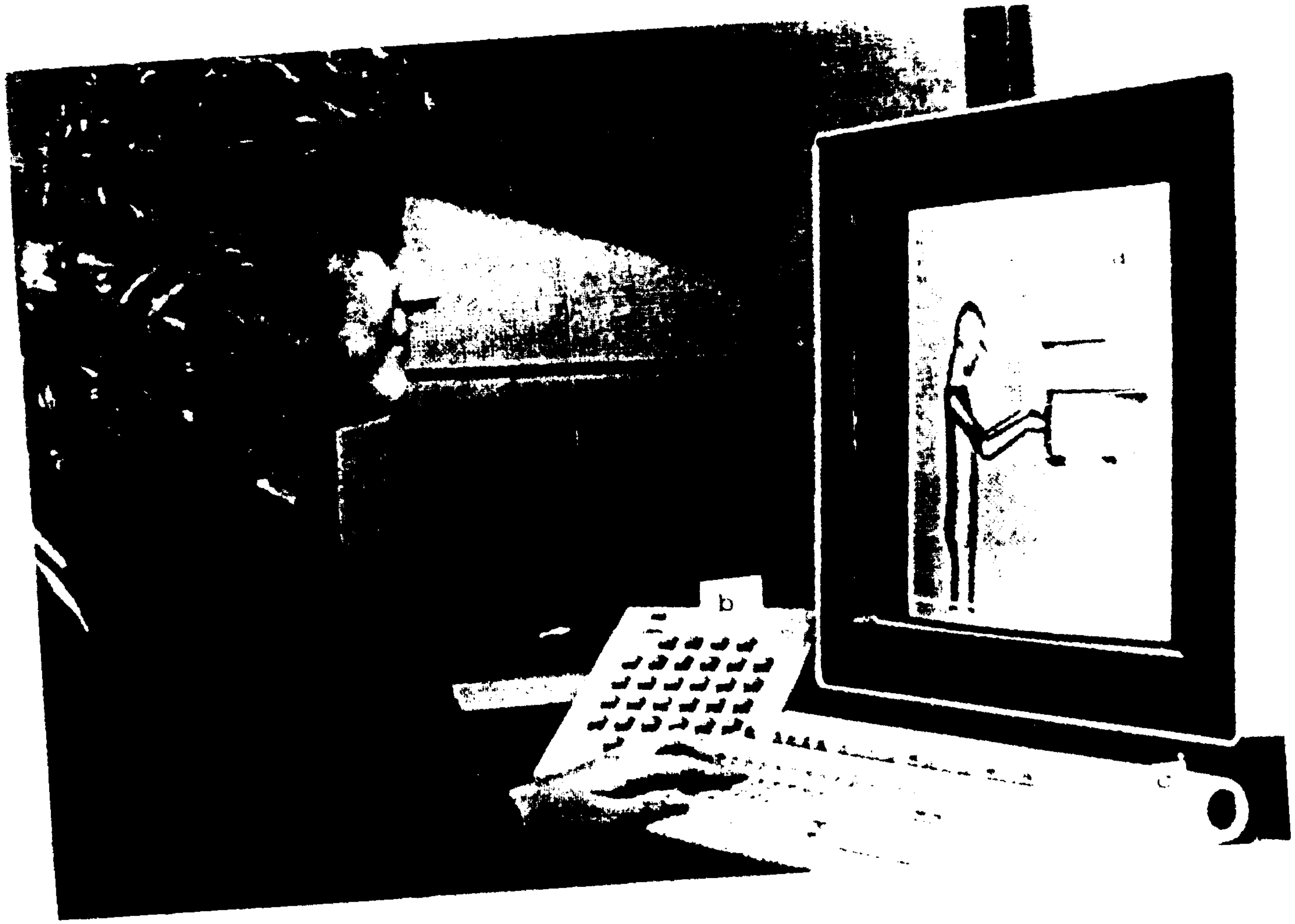


Figure 1.2. CRT Screen (a), Function Keyboard (b), and Alphanumeric Keyboard (c). The Operator Depressed the ACCESS Function Key to execute CREW CHIEF.

Once the CREW CHIEF Main menu is activated, the user is presented with the CREW CHIEF Main programs (see Figure 1.3). This menu contains the five main functions. The CREW CHIEF Generation function must be selected prior to using any of the other four major functions. To use any other function, select the function icon.

1.5 VERSION 2 ENHANCEMENTS

Several have been added to the Version 2 release of CREW CHIEF. A brief description of each follows.

- Interactive User ELxit (IUE)
  Version 2 is directly interfaced to the CADAM software through the Interactive User Exit (IUE) and uses many of the capabilities associated with this interface. With IUE, icons, along with text descriptions, have been added to each CREW CHIEF function.

- The CREW CHIEF Reposition function is now fully incorporated into Version 2. This function allows a user to manipulate specific types of man-model movement.

- The Chemical Defense Clothing type has been changed to conform to that currently in use by the Air Force.

- The CREW CHIEF Tool Analysis interface and Tool Database have been enhanced to include additional sizes of tools in the tool box. There were 105 separate tools in the Version 1 tool box, and there are 222 in the Version 2 tool box.

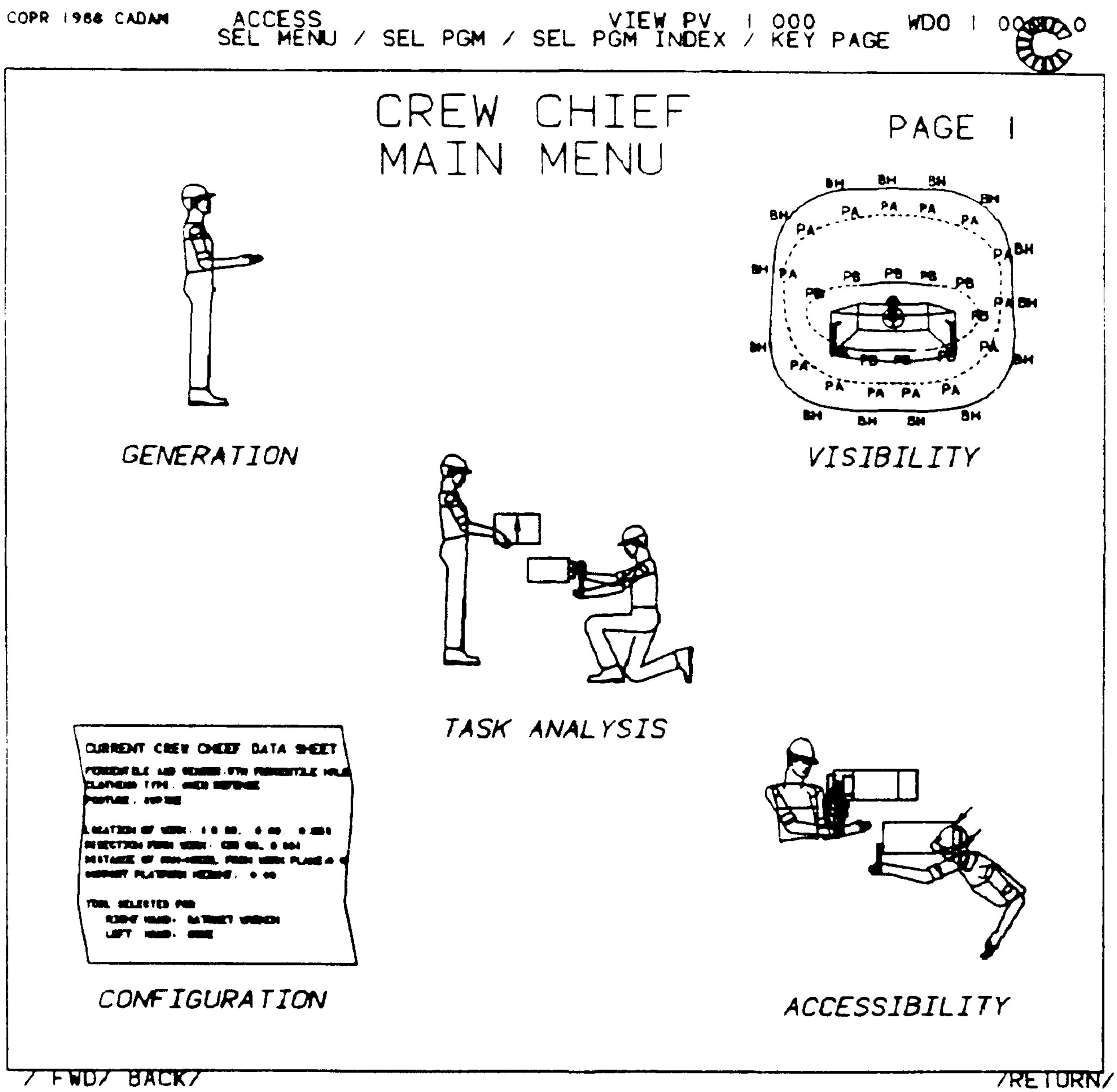


Figure 1.3. Menu for CREW CHIEF Main Programs.

- Two database maintenance programs were added to Version 2.

    - The Anthropometric Database Maintenance program provides the user the ability to input a different anthropometric database (Appendix E).
    - The Tool Database Maintenance program allows the user to define additional tools and add them to the tool box for their use (Appendix F).

1.6 GETTING STARTED

Since the CREW CHIEF and CADAM programs are interactive, there are basically three initial requirements to get started: (1) access the CADAM programs, (2) retrieve a 3-D drawing from the CADAM drawing files, and (3) call the CREW CHIEF system of programs. The basic steps to meet these requirements follow.

Step 1:

ACTION: Submit a CADAM job on alphanumeric keyboard (ANKB) that will access the CREW CHIEF programs. For example, key in **SUBMIT 'CREW.CHIEF.CNTL(RUNCCF)'**.

RESULT: The first prompt appears.

Step 2:

PROMPT: COLD START

WARM START (prompt appears in bottom third of window)

ACTION: Select **COLD START**

RESULT: Screen display area is blank and a new prompt appears.

Step 3:

PROMPT: KEY GROUP, USER

ACTION: Key in user's group and sub-group ID **<CR>** (e.g. CREW,IUE)

RESULT: Screen display area is blank. FILES appears in upper left-hand corner of window. GROUP = and USER = appear in upper right-hand corner, and a new prompt and menu appears.

Step 4:

PROMPT: There is no visual prompt.

ACTION: Select **PROFILE** from bottom menu:

/START/CALL/FILE/DATA-M/GRPUSR/INFO/SPLIT/MERGE

/PROFILE/OUTPUT/LOGOFF/

RESULT: Drawing/Screen Configuration options are shown in the window with asterisks indicating status of configuration (Figure 1.4). A new prompt appears.

Step 5:

PROMPT: SELECT OPTION/YN RETURN

ACTION: Select **3D** under MODE in bottom half of window. Next select **/RETURN/** beneath right-hand corner of window.

RESULT: Asterisks appear before 3D beneath MODE and WINDOW, and after /RETURN/ is selected, display area is

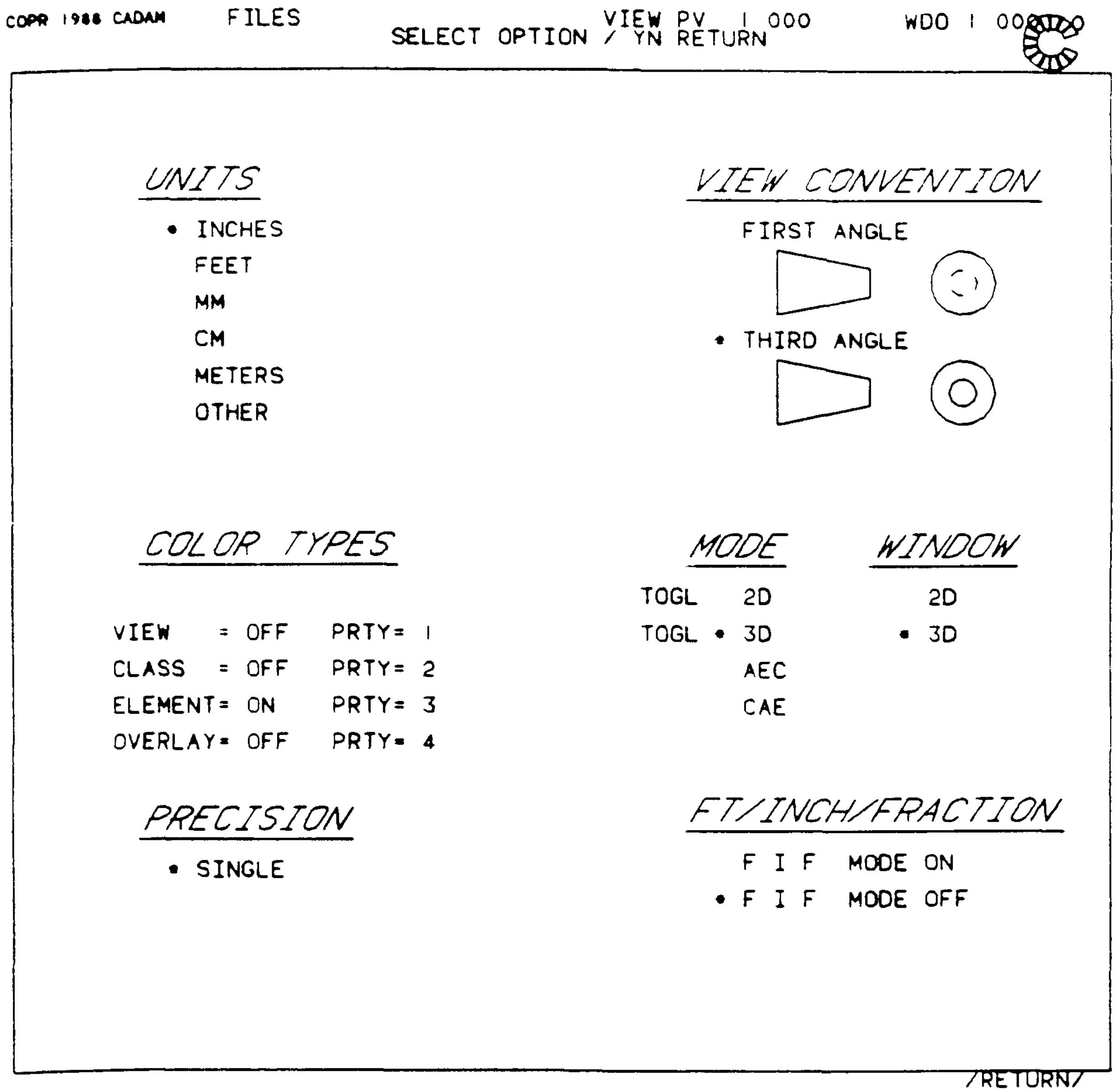


Figure 1.4. User-Defined Drawinq/Screen Configurations.

blank and top prompt and bottom menus remain the same as in Step 4.

Step 6:

PROMPT: There is no visual prompt.

ACTION: Select **/CALL/** from bottom menu to key in drawing name or to access user's drawing file:

/START/CALL/FILE/DATA-M/GRPUSR/INFO/SPLIT/MERGE

/PROFILE/OUTPUT/LOGOFF/

RESULT: CALL is underlined and a new prompt appears.

Step 7:

PROMPT: KEY PN, FN / Y/N CALL

ACTION: Depress **Y/N** (YES/NO) function key.

RESULT: First page of user's drawing file index appears on screen. A new prompt and a new menu appear.

Step 8:

PROMPT: SEL ID/KEY PAGE NO

ACTION: Select a drawing file name (ID)

RESULT: Selected drawing is retrieved and displayed on screen. PN,FN = (ID selected) appears in the top left-hand corner of the window under FILES. The drawing may have to be oriented by depressing the CADAM Window function key. Once the drawing has

been oriented as desired, the CREW CHIEF system of programs may be called.

Step 9:

PROMPT: There is no visual prompt.

ACTION: Depress **ACCESS** function key.

RESULT: Screen display changes, a new prompt and a new menu appear.

Step 10:

PROMPT: SEL MENU

ACTION: Select **/EXECUTE IUE PGM/** from the bottom menu.

RESULT: The IUE PROGRAM DIRECTORY appears.

Step 11

PROMPT: SEL MENU/SEL PGM/ SEL PGM INDEX/KEY PAGE

ACTION: Select **3D INTERACTIVE PROGRAMS** under the CADAM-SUPPLIED IUE APPLICATION PROGRAMS.

Step 12

PROMPT: SEL MENU/SEL PGM/ SEL PGM INDEX/KEY PAGE

ACTION: Select the **CREW CHIEF** option.

RESULT: The CREW CHIEF Main Programs menu appears (see Figure 1.3). Information concerning the generation of the man-model and the use of the analysis functions is contained in Sections 2

through 6. If the user wishes to proceed directly to the initial generation of the man-model, the user may turn to Paragraph 2.1.2 for generation procedures.

NOTE: During the execution of any CREW CHIEF function, a menu will be present at the bottom of the window:

/TO MAIN MENU/TO PREVIOUS MENU/EXIT FUNCTION/HELP/.

The options in this menu allow the user to exit to the main menu, backup to a previous menu, exit IUE, or obtain help information.

The following sections contain a PROMPT, ACTION, EXAMPLE, RESULT format. The user is invited to follow the examples **exactly** to ensure the user's ease in learning efficient use of the CREW CHIEF system of programs. Section 8 of this User's Guide is provided as a Quick Reference for a user who has become familiar with the CREW CHIEF system of programs. This section is written in a PROMPT, ACTION, RESULT format, and includes all possible branches of each CREW CHIEF function. Note that all prompts appear at the top of the window. Icons have also been included in the CREW CHIEF interface. Each icon has a text description under it for better understanding.

SECTION 2
CREW CHIEF GENERATION FUNCTIONS

The CREW CHIEF Generation Functions menu contains all functions which pertain to the generation, display, and manual repositioning of the CREW CHIEF man-model. This is normally the first menu accessed, since several CREW CHIEF functions require a man-model to be defined before use. This menu contains four functions: CREW CHIEF Initialization, Paragraph 2.1.2, which generates and displays the man-model; CREW CHIEF Regeneration, Paragraph 2.2.2, which regenerates the CREW CHIEF man-model display using the most recent saved data; CREW CHIEF Reposition, Paragraph 2.3, which places the man-model (in the desired posture and position) in the work space; and CREW CHIEF Head Orientation, Paragraph 2.4.2, which turns the head to allow the man-model to view a new location. Choose the function to be used by selecting the appropriate icon for that function (Figure 1.3).

2.1 CREW CHIEF INITIALIZATION FUNCTION

2.1.1 Introduction to Initialization Function

The CREW CHIEF Initialization Function generates and displays the man-model in the designer's drawing. The designer can choose from ten body sizes (including five male and five female), four clothing types, and twelve initial postures. These choices allow multiple options to evaluate a design for maintainability. The man-model can be placed anywhere in the drawing, but is not made a permanent part of the drawing unless specifically requested. Any man-model not made a permanent part of the drawing is erased upon the generation of another man-model. This prevents the programs from permanently corrupting the designer's drawing.

The ten body sizes consist of the 1st, 5th, 50th, 95th, and 99th percentiles for both male and female, based on the Air Force maintenance technician population. Selection of the Nth

percentile results in the generation of a man-model with Nth percentile height, weight, and arm length for the selected gender. Other necessary body dimensions are calculated from regressions based on these three variables. Appendix A describes the generation of the man-model, and the selection of body size as applicable to Air Force design policy.

The four common clothing ensembles used by a technician are fatigues, fatigues with jacket, arctic, and chemical defense (see Figures B.1-B.4 in Appendix B). Details of the clothing ensembles are contained in Appendix B. Figures B.5 through B.8 show the man-model as it appears in each of these clothing ensembles.

The twelve postures represent common postures found in a maintenance environment. These postures allow initial generation of the man-model in a posture which closely approximates the one desired. The initial postures can be further modified manually (using the Reposition Function), or automatically by the Task Analysis Functions. The twelve postures available in the Initialization Function can be seen in Figures C.1 through C.12 in Appendix C.

2.1.2 Using the Initialization Function

These instructions for the Initialization Function assume that the CREW CHIEF system of programs has been activated and that the screen is configured as shown in Figure 1.3. If not, the user must complete the procedure described in Paragraph 1.5 to call the CREW CHIEF Main Programs menu. The next step is to generate the man-model in the desired configuration.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **GENERATION icon**

RESULT: The CREW CHIEF Generation Functions menu is displayed (Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **INITIALIZATION icon**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Initialization function.

EXAMPLE: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM INIUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT DESIRED BODY SIZE

ACTION: Select the icon representing the body size and gender of the man-model (Figure 2.2). (See Appendix A for explanation of body size percentiles.)

EXAMPLE: Select **50TH PERCENTILE**

RESULT: New prompt and menu appear.

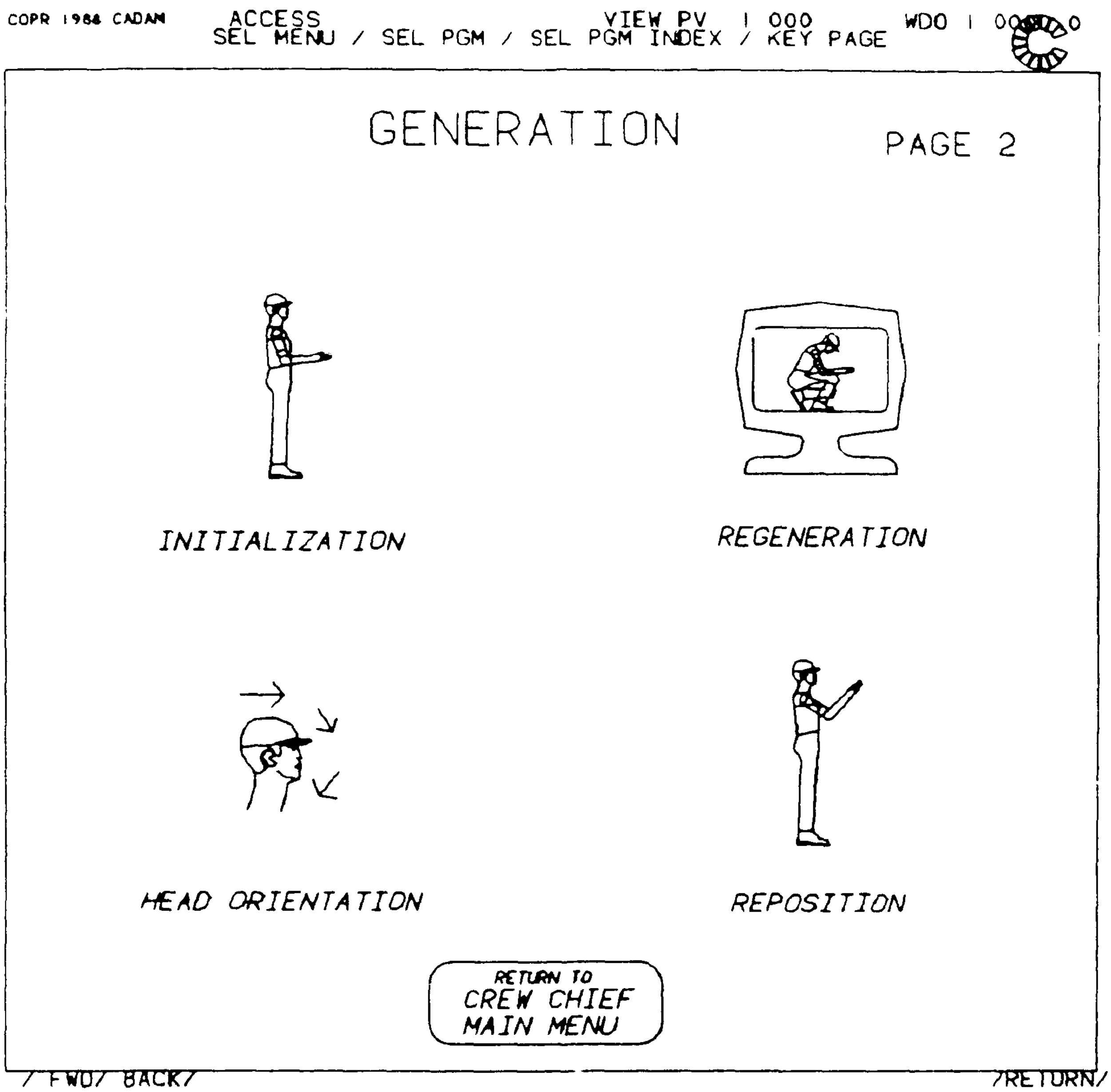


Figure 2.1. Main Menu for CREW CHIEF Generation Functions.

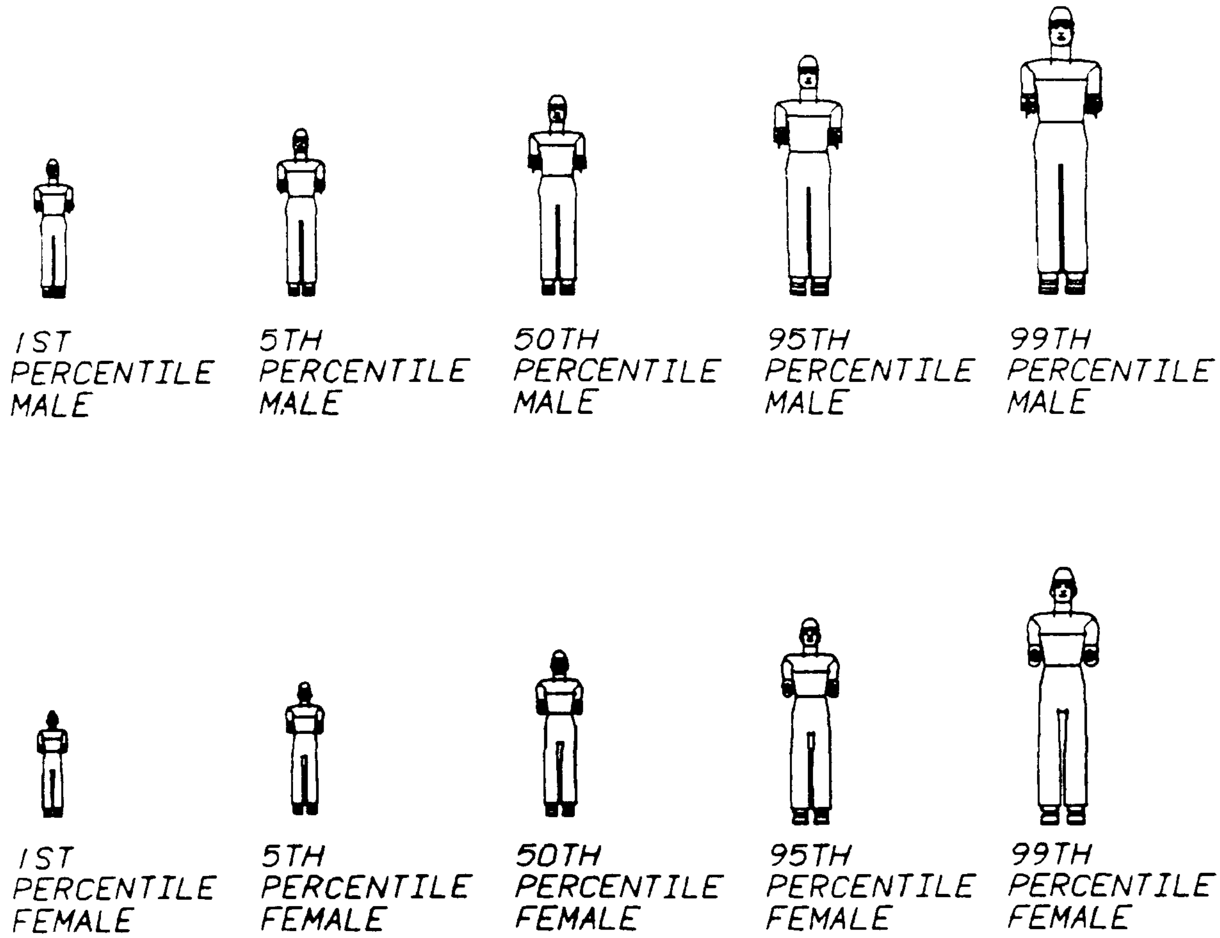


Figure 2.2. Body Size Menu.

PROMPT: SELECT DESIRED CLOTHING TYPE

ACTION: Select the icon representing the type of clothing to be worn by the man-model (Figure 2.3). Clothing affects mobility and accessibility. See Appendix B for explanation of clothing types.

EXAMPLE: Select **FATIGUES**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED POSTURE

ACTION: Select icon representing the starting posture of the man-model (Figure 2.4). See Appendix C, Figures C.1-C.12 for explanation of postures. Later these postures can be adjusted manually using the Reposition function or will be automatically adjusted when performing Task Analysis.

EXAMPLE: Select **KNEEL 2**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED POSITION MODE

ACTION: Select choice from options in the middle of the screen

- Select **NEW POSITION AND ORIENTATION** to define the man-model at a new position and orientation.

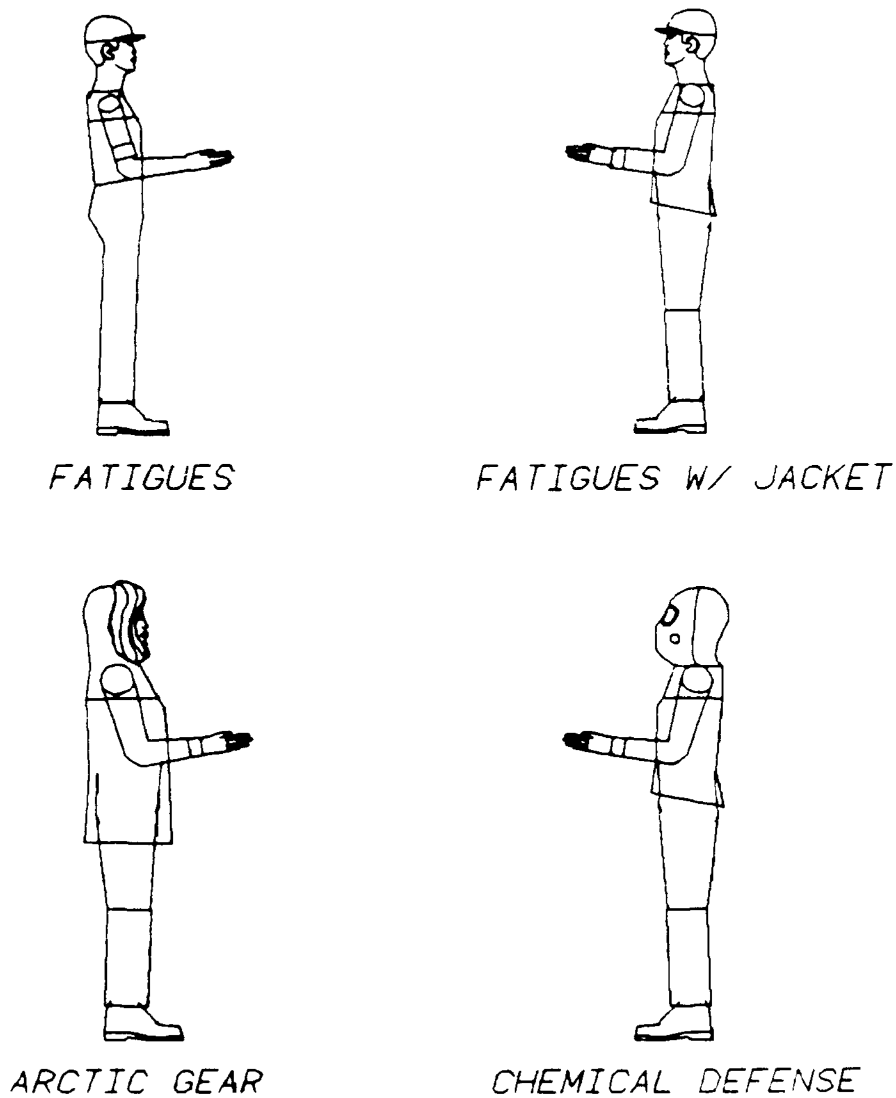


Figure 2.3. Clothing Menu.

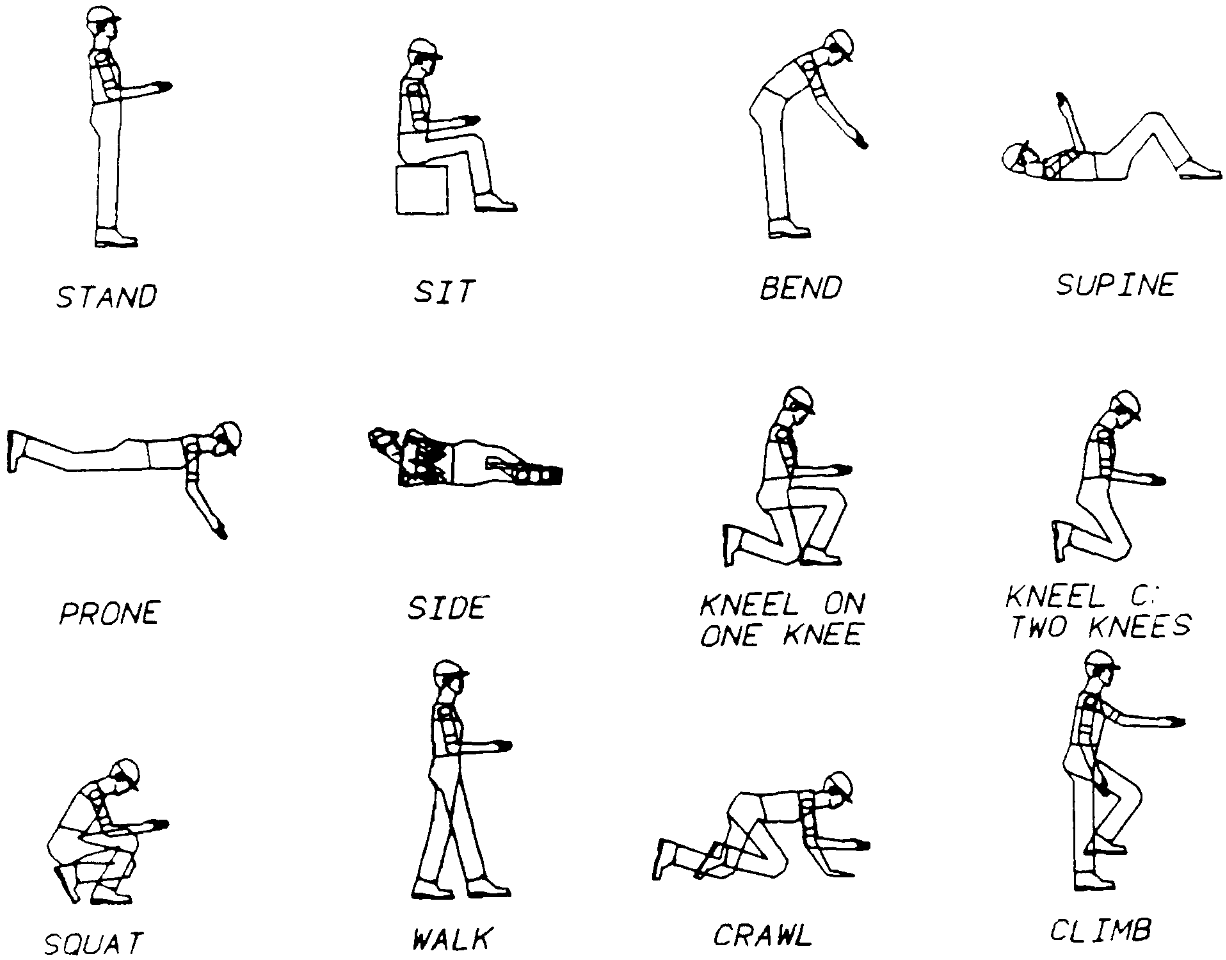


Figure 2.4. Posture Menu.

OR:

- Select **OLD POSITION AND ORIENTATION** to place man-model in the same location and orientation as previously defined during Initialization. The user will next be prompted to choose a display type if this option is selected. (Gender-size, clothing type, and posture type may change if the user indicates a change.)

OR:

- Select **CURRENT POSITION AND ORIENTATION** to re-display the man-model in the current saved position and orientation. This position and orientation could have been generated in several of the CREW CHIEF functions such as Task Analysis.

  The user would next be prompted to choose a display type if this option is selected.

EXAMPLE: Select **NEW POSITION AND ORIENTATION**

RESULT: New prompt appears on screen to select display type.

As a result of selecting NEW POSITION AND ORIENTATION, the user will see the following prompt:

PROMPT: DEFINE POINT FOR LOCATION OF WORK

ACTION: Define the location of work (bolt head or target area of man-model's work) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point. The X and Y coordinates of this point determine the head of the direction

vector shown in Figure 2.5. The man-model always faces the location of work.

- Select an existing 3-D point to define the location of work.

OR:

- Key in the X,Y,Z coordinates of the location of work **<CR>**.

EXAMPLE: Key in **24, 163.5, 0** on ANKB **<CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR DIRECTION FROM WORK

ACTION: Define a direction *from the man-model* to the Location of Work. **Note that this is NOT the location of the man-model.** Define the X, Y coordinates of a point relative to the Location of Work point. This point defines the tail point of the direction vector along which the man-model will be placed as shown in Figure 2.5. The distance of this point from the Location of Work is not relevant at this stage of initialization.

- Select an existing point in the drawing. Only the location of the man-model. Only the X,Y coordinates will be used to define this direction.

OR:

- Key in the X,Y coordinates of the direction point **<CR>**.

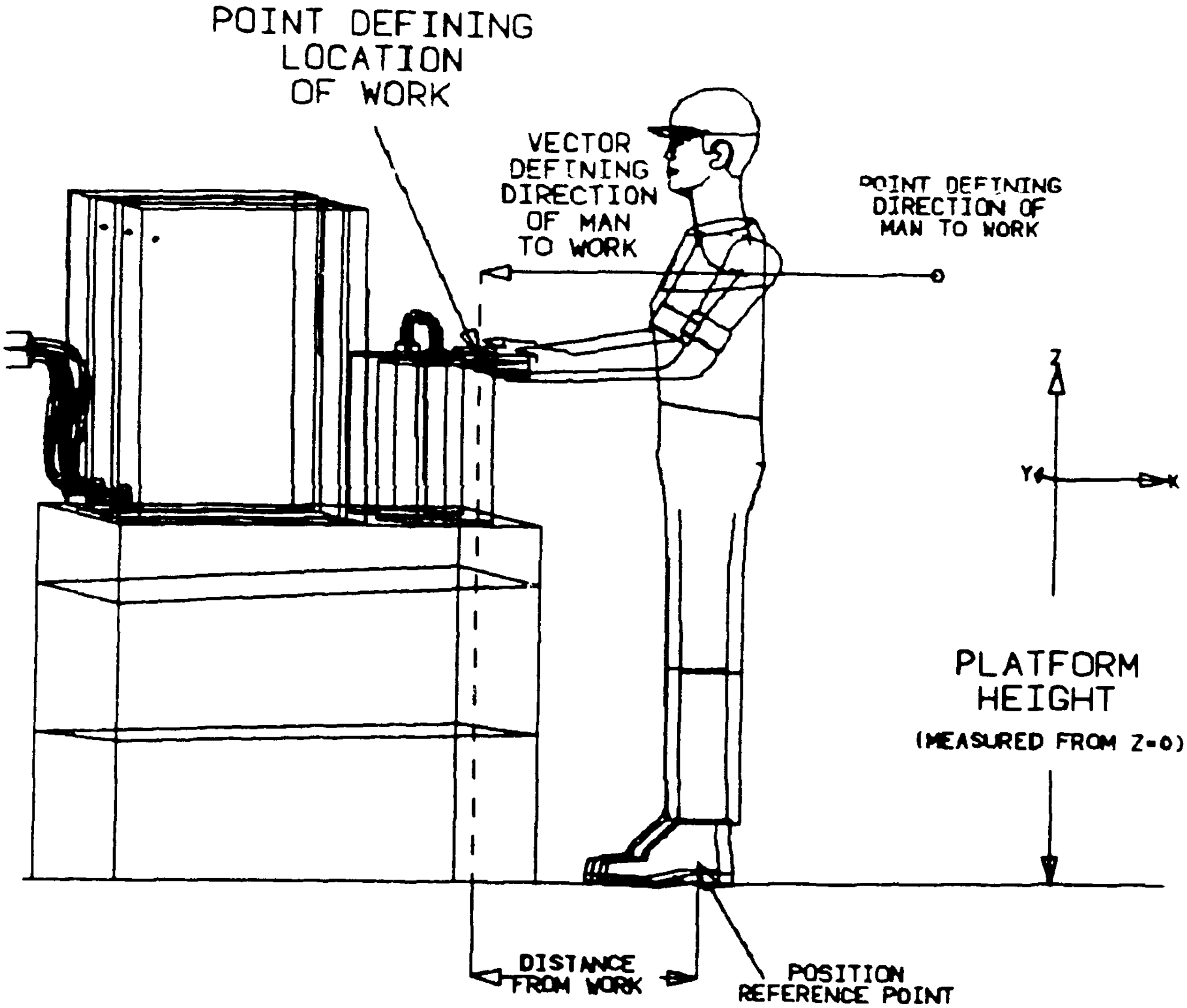


Figure 2.5. The Man-Model at a Work Station with Arrows Showing Position and Orientation Requirements.

EXAMPLE: Key in **35, 163.5 <CR>**

RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE FROM WORK

ACTION: Define the horizontal distance from the Location of Work point to the man-model. The Position Reference Point of the man-model lies along the vertical plane defined by the Location of Work and the Direction to Work (see Figure 2.5). (See Appendix C for location of Position Reference Points for various postures.) Key in the distance between man-model and the Location of Work **<CR>**. Values outside the range of 6-30 inches are usually unrealistic, but this distance depends upon the location of the Position Reference Point of the selected posture as shown in Figure 2.6.

EXAMPLE: Key in **12 <CR>**.

RESULT: New prompt and menu appear.

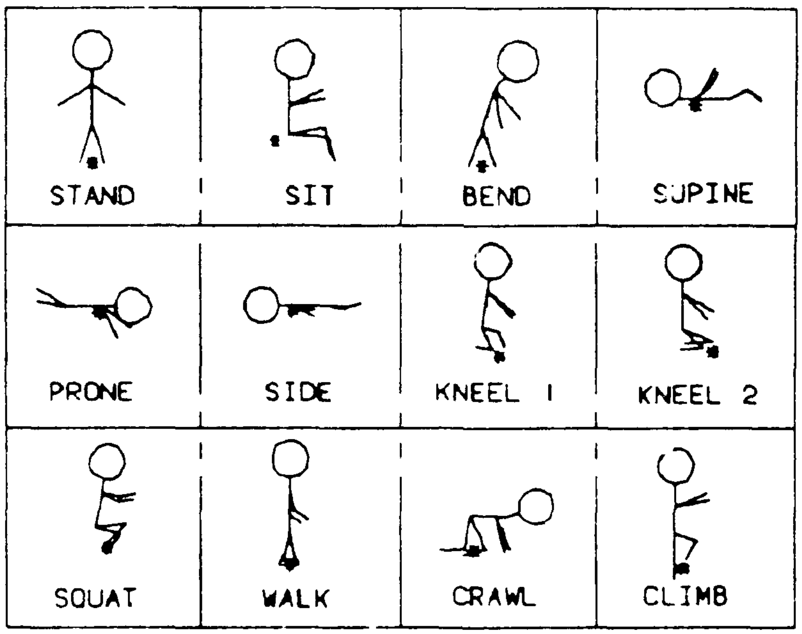
PROMPT: SELECT PLATFORM INPUT MODE

ACTION: Define the height of the platform or support surface upon which the man-model will be positioned. The Position Reference Point (see Figure 2.6) of the man-model will be placed at this height.

C) DISTANCE FROM WORK:

DISTANCE FROM THE POSITION REFERENCE POINT OF THE CREW CHIEF TO THE LOCATION OF WORK.

(*) POSITION REFERENCE POINTS



MORE HELP AVAILABLE ON NEXT PAGE

Figure 2.6. Position Reference Points.

- Choose **SELECT WORK PLATFORM POINT** to define an existing 3-D point in the drawing which will represent the height (Z coordinate) of the platform or support surface, and then select an existing 3-D point.

OR:

- Select **KEY-IN PLATFORM HEIGHT** to key in the height of the platform or support surface (Z coordinate) relative to the drawing origin, and key in the , coordinate **<CR>**.

EXAM 'LE: Select **KEY-IN PLATFORM HEIGHT**

RESULT: New prompt appears.

PROMPT: KEY-IN PLATFORM HEIGHT

ACTION: Key-in the value representing the platform height **<CR>**

EXAMPLE: Key-in **-20 <CR>**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the display type icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model

TABLE 2.1. THREE TYPES OF DISPLAY AVAILABLE FOR THE CREW CHIEF MAN-MODEL.

Type of Man-Model	Definition
(1) WIRE	This selection generates the man-model as a 3-D wire-frame figure which can be rotated and moved using the appropriate CADAM Window (PFK 27) functions. The man-model and drawing may be viewed from different points in the drawing. This type of enfleshment can be used for visually identifying potential areas of interference between the man-model and the workplace design (Figure 2.7.).
(2) SURFACED	This type of display will display the man-model as a 3d meshed model. The man-model can then be shaded by using CADAM's Shading program under IUE (Figure 2.8.).
(3) PROFILE	This is a profile view of the man-model, as seen from the designer's viewpoint at the graphics scope. This type of display is the least cluttered, and provides a display suitable for "finished" plots (Figure 2.9.).

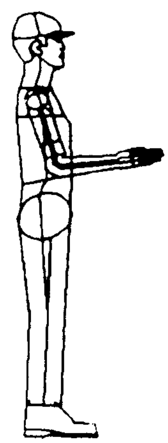


Figure 2.7. 3-D Wire-Frame Man-Model.

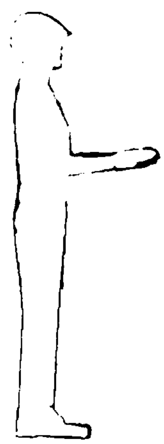


Figure 2.8. Surfaced View of Man-Model.

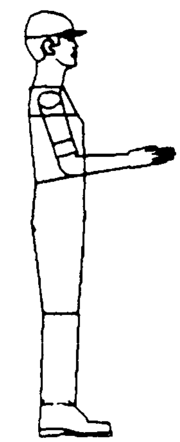


Figure 2.9. Profile View of Man-Model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**

RESULT: Man-model appears superimposed on the drawing as a wire-frame model, and new prompt and new menu appear.

NOTE: If user has followed the examples, the man-model appears kneeling on both knees with his knees 20 inches below the origin and 12 inches offset from the location of work.

When the man-model has been positioned in the drawing, the Initialization function is completed. To continue the analysis, the user will generally select **/RECOVER/** from the menu at the bottom of the window. The bottom menu is a CADAM-supplied menu which also contains another selection which is available to the user at this time. The /KEEP/ option saves the man-model in a drawing called OVERLAY. If /KEEP/ is selected the drawing OVERLAY becomes the active drawing.

PROMPT: SEL MENU

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/RECOVER/** will return the user to the CREW CHIEF Generation Functions menu (see Figure 2.1) without saving the current man-model.

EXAMPLE: Select **/RECOVER/**

RESULT: Program returns to CREW CHIEF Generation Functions menu (see Figure 2.1).

Figure 2.10 diagrams the flow of actions necessary to execute an initialization of the man-model.

2.2 CREW CHIEF REGENERATION FUNCTION

2.2.1 Introduction to Regeneration Function

The Regeneration Function regenerates the man-model display, using the last saved enfleshment data from the last successful positioning operation. Positioning operations can occur during the Generation functions, or during a Task Analysis, and are saved from one program run to the next if successful positioning has occurred. The Regeneration Function provides the user the opportunity to change both the type of display presented and the viewpoint from which the user sees the man-model (for profile view). This function can be used to recover from any catastrophic errors that may occur during interactive repositioning of the man-model. These instructions for the Regeneration function assume that the man-model has been generated at least once using the Initialization function (see Paragraph 2.1.2).

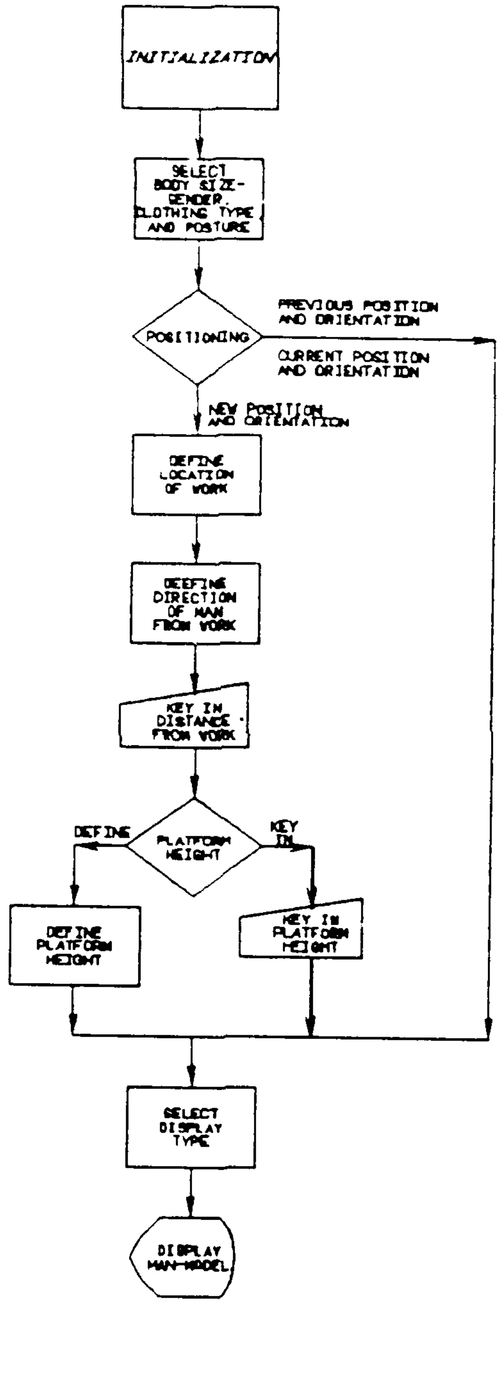


Figure 2.10. CREW CHIEF Initialization Function Flow Diagram.

2.2.2 Using the Regeneration Function

These instructions for the Regeneration function assume that the CREW CHIEF system of programs has been activated and that the screen is configured as shown in Figure 1.3.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **GENERATION icon**

RESULT: The CREW CHIEF Generation Functions menu is displayed (see Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **REGENERATION icon**

RESULT: A new prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Regeneration Function.

EXAMPLE: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM REGUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE)

- Select **WIREFRAME** to display a 3-D wire-frame man-model

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading

OR:

- Select **PROFILE** to display profile view of man-model

EXAMPLE: Select **WIREFRAME**

RESULT: Man-model appears superimposed on the drawing as a profile model, and new prompt and new menu appear.

NOTE: If user has followed the examples, the man-model will appear as he did in the last successful generation. The only item which may change is the display type.

When the man-model has been positioned in the drawing, the Regeneration function is completed. To continue the analysis, the user will generally select **/RECOVER/** from the menu at the bottom of the window. The bottom menu is a CADAM-supplied menu which also contains another selection which is available to the user at this time. The /KEEP/ option saves the man-model in a drawing called OVERLAY. If /KEEP/ is selected, OVERLAY becomes the active drawing.

PROMPT: SEL MENU

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/RECOVER/** will return the user to the CREW CHIEF Generation Functions menu without saving the current man-model.

EXAMPLE: Select **/RECOVER/**

RESULT: Program returns to CREW CHIEF Generation Functions menu.

Figure 2.11 diagrams the flow of actions necessary to execute a regeneration of the man-model.

2.3 CREW CHIEF REPOSITION FUNCTION

2.3.1 Introduction to Reposition Function

The Reposition function is designed to augment the Task Analysis functions which will usually position the man-model in the chosen position. However, sometimes an uncommon position or a position necessitating movement of peripheral body sections may be desired. For example, a reach may only require movement of an arm, but the user may also require that the body be twisted or a leg be moved. Reach will not move these peripheral sections unless the movements are required for a successful reach. Reposition allows movement of up to twelve body sections at any time. When the man-model is regenerated using the Reposition function, mobility restraints will still be enforced, but interference is not checked. It is possible, but slower, to accomplish a reach using only the Reposition function.

The Reposition function is different from the rest of the CREW CHIEF functions. This function can be executed over and over until the user is satisfied with the positioning of the man-

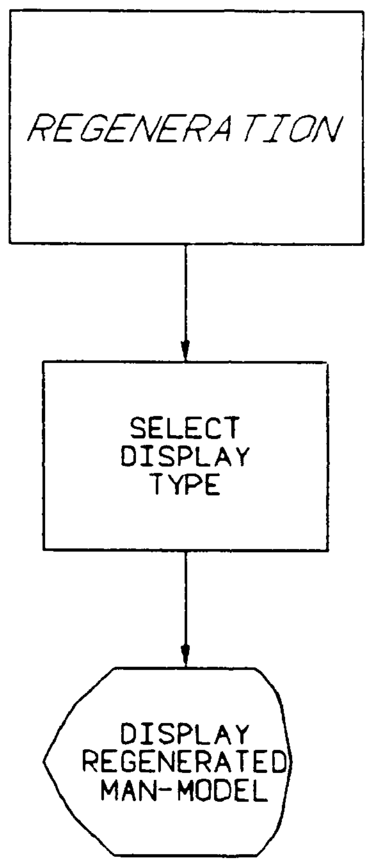


Figure 2.11. CREW CHIEF Regeneration Function Flow Diagram.

model. The user will select **/EXIT FUNCTION/** from the bottom menu when he is ready to exit the function. See Section 1.5 for a description of this bottom menu.

2.3.2 Using the Reposition Function

These instructions for the Reposition Function assume that the CREW CHIEF system of programs has been activated and that the screen is configured as shown in Figure 1.3.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **GENERATION icon**

RESULT: The CREW CHIEF Generation Functions menu is displayed (see Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **REPOSITION icon**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Reposition function.

EXAMPLE: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM RPNUSR EXECUTING appears, man-model is initialized in the last successful position and appears in the drawing, and then a new prompt appears.

PROMPT: SELECT THE OPTION YOU WISH TO USE

ACTION: Select the option you wish to perform

- Select **REORIENT A MAN-MODEL SEGMENT** to rotate and/or twist specific segments of the man-model

OR:

- Select **DEFINE NEW POSITION REFERENCE POINT** to define a new position reference point on the man-model. Figure 2.6 defines the position reference point for each posture

OR:

- Select **REORIENT THE ENTIRE MAN-MODEL** to define a new support platform or rotate entire man-model

OR:

- Select **SQUAT FROM AN UPRIGHT POSTURE** to allow the man-model to be positioned in a squat posture.

EXAMPLE: Select **REORIENT A MAN-MODEL SEGMENT**

RESULT: New prompt appears.

PROMPT: SELECT MAN-MODEL SEGMENT YOU WISH TO REORIENT

ACTION: Select the body segment you wish to rotate or twist.

EXAMPLE: Select a segment in the lower arm.

RESULT: A new prompt and menu appears.

PROMPT: SELECT THE OPTION YOU WISH TO USE

ACTION: Select option whether to flex or twist the selected segment.

EXAMPLE: Select **FLEX THE SELECTED MAN-MODEL SEGMENT**

RESULT: New prompt appears.

PROMPT: KEY IN INCREMENT FOR FLEXED ANGLE IN DEGREES

ACTION: Key in the angle of flexion in degrees **<CR>**. The default is ten degrees and can be obtained by **<CR>**. Otherwise key in the angle desired **<CR>**.

EXAMPLE: Key in **15 <CR>**

RESULT: Man-model reappears on screen with lower arm flexed 15 degrees. New prompt appears.

PROMPT: KEY IN INCREMENT FOR FLEXED ANCLE IN DEGREES

ACTION: Key in a new angle of flexion or **<CR>** for same angle. If the user is satisfied with the location of the body segment, he can select **/TO PREVIOUS**

MENU/ from the bottom menu. This will return him to a new menu.

EXAMPLE: **<CR>**

RESULT: Man-model reappears on screen with lower arm flexed 15 degrees more. Same prompt appears.

PROMPT: KEY IN INCREMENT FOR FLEXED ANGLE IN DEGREES

ACTION: Key in a new angle of flexion or **<CR>** for same angle. If the user is satisfied with the location of the body segment, he can select **/TO PREVIOUS MENU/** from the bottom menu. This will return him to a new menu.

EXAMPLE: Select **/TO PREVIOUS MENU/** from bottom menu

RESULT: New prompt and menu appears.

PROMPT: SELECT THE OPTION YOU WISH TO USE

ACTION: Select the option to flex or twist a man-model segment from the screen. At any time the user can select one of the options from the bottom menu if he is satisfied with the position of a given segment.

EXAMPLE: Select **/TO PREVIOUS MENU/**

RESULT: New prompt appears.

PROMPT: SELECT THE MAN-MODEL SEGMENT YOU WISH TO REORIENT

ACTION: Select the man-model segment you wish to re-orient or select one of the options from the bottom menu.

EXAMPLE: Select **/TO PREVIOUS MENU/**

RESULT: New prompt and menu appear.

PROMPT: SELECT THE OPTION YOU WISH TO USE

ACTION: Select the option you wish to perform from the screen.

- Select **ABORT CURRENT MAN-MODEL TO RECOVER** to recover position of man-model before last save command was given.

OR:

- Select **REORIENT A MAN-MODEL SEGMENT** to rotate or twist specific segments of the man-model.

OR:

- Select **DEFINE NEW POSITION REFERENCE POINT** to define a new position reference point on the man-model. Figure 2.6 defines the position reference point for each posture.

OR:

- Select **REORIENT THE ENTIRE MAN-MODEL** to define a new support platform or rotate entire man-model.

OR:

- Select **SQUAT FROM AN UPRIGHT POSTURE** to allow the man-model to be positioned in a squat posture.

OR:

- Select one of the options at the bottom of the menu.

EXAMPLE: Select **/EXIT FUNCTION/**

RESULT: New prompt and menu appear.

PROMPT: SELECT THE OPTION YOU WISH TO USE

ACTION: Select the option from the screen you wish to use. Before exiting Reposition Function the user has the choice to save the man-model in the current configuration or exiting without saving the new man-model configuration.

- Select **SAVE THE MAN-MODEL AND RESUME THE FUNCTION** to save the current man-model configuration and continue with the Reposition function.

OR:

- Select **SAVE MAN-MODEL AND EXIT THE FUNCTION** to save current position of the man-model and exit the function.

OR:

- Select **EXIT FUNCTION WITHOUT SAVING** to exit the Reposition function and recover the position of

the man-model before the last save command was given.

EXAMPLE: Select **SAVE THE MAN-MODEL AND EXIT THE FUNCTION**

RESULT: New prompt and menu appear.

To continue the analysis, the user will generally select **/RECOVER/** from the menu at the bottom of the window. The user may select /KEEP/ to save the man-model in the drawing OVERLAY. If /KEEP/ is selected, OVERLAY becomes the active drawing.

PROMPT: SEL MFNU

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/RECOVER/** will return the user to the CREW CHIEF Generation Functions menu without saving the current man-model.

EXAMPLE: Select **/RECOVER/**

RESULT: Program returns to CREW CHIEF Generation Functions menu.

Figure 2.12 diagrams the flow of actions necessary to execute the Reposition Function.

2.4 CREW CHIEF HEAD ORIENTATION FUNCTION

2.4.1 Introduction to Head Orientation Function

This function allows the user to specify a new point toward which the man-model will turn its head as far as mobility constraints will allow. The man-model's head i oriented to look

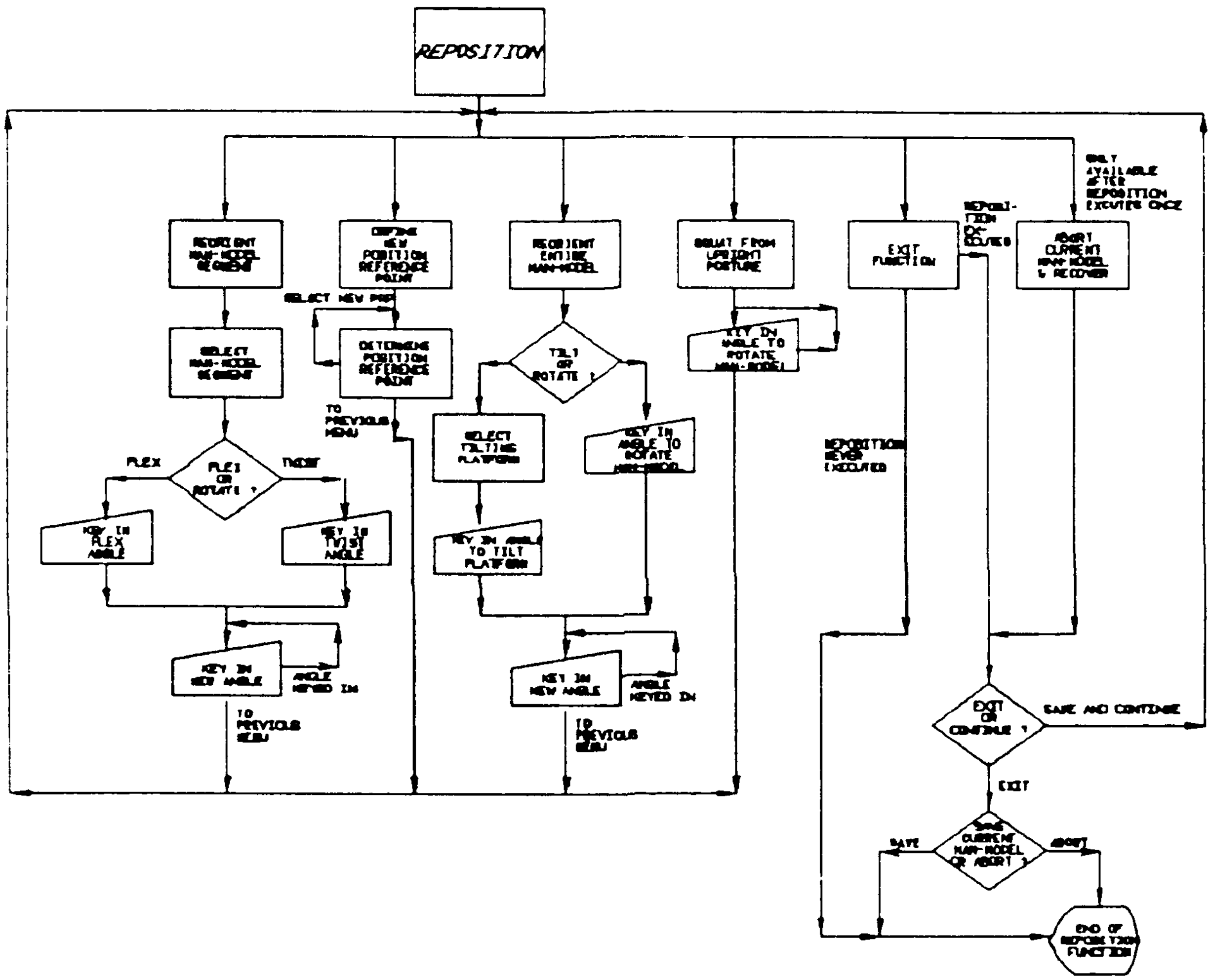


Figure 2.12. CREW CHIEF Reposition Function Flow Diagram.

toward the new location instead of toward the previously specified location.

2.4.2 Using the Head Orientation Function

These instructions for the Head Orientation Function assume that the CREW CHIEF system of programs has been activated and that the screen is configured as shown in Figure 1.3.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed.

EXAMPLE: Select the **GENERATION icon.**

RESULT: The CREW CHIEF Generation Functions menu is displayed (see Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed.

EXAMPLE: Select the **HEAD ORIENTATION icon.**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Head Orientation function.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM HDOUSR EXECUTING appears and then a new prompt and menu appear. PROMPT: DEFINE TARGET POINT.

ACTION: Select or key in a 3-D point which will represent the point toward which the man-model will turn its head. If mobility constraints will allow, the man-model will look directly at the point. If mobility constraints do not allow desired head positioning, the man-model's head will turn as far as possible toward the point. To determine the man-model's new head orientation:

- Select an existing 3-D point in the drawing.

OR:

- Key in X,Y,Z coordinates of the target point, **<CR>**

EXAMPLE: Key in **60, 10, 10 <CR>**.

RESULT: New prompt appears.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME.**

RESULT: New prompt appears.

RESULT: Man-model appears superimposed on the drawing as a wire-frame man-model with its head oriented toward the target point

When the man-model's head has been oriented, the Head Orientation function has been completed. To continue the analysis, the user will generally select **/RECOVER/** from the menu at the bottom of the window. The user may select /KEEP/ to save the man-model in the drawing OVERLAY. If /KEEP/ is selected, OVERLAY becomes the active drawing.

PROMPT: SEL MENU

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/RECOVER/** will return the user to the CREW CHIEF Generation Functions menu without saving the current man-model.

EXAMPLE: Select **/RECOVER/**

RESULT: Program returns to CREW CHIEF Generation Functions menu.

Figure 2.13 diagrams the flow of actions necessary to execute a head orientation of the man-model.

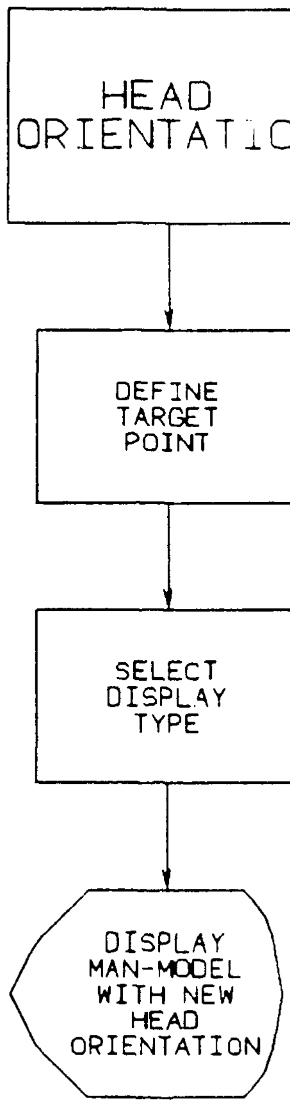


Figure 2.13. CREW CHIEF Head Orientation Function Flow Diagram.

SECTION 3
MAINTENANCE TASK ANALYSES

The Maintenance Task Analyses function is designed to evaluate the interactions of the CREW CHIEF man-model and the user's design with respect to certain physical characteristics of the man-model. The function is separated into three parts: the Tool Analysis function (Paragraph 3.1), the Materials Handling function (Paragraph 3.2), and the Connector Analysis function (Paragraph 3.3).

The Tool Analysis function evaluates the ability to reach, with a tool and from a designated posture and position, a specified task point. This includes the ability to reach around obstacles between the man-model (holding the tool) and the task point can be reached, the strength capability (force that can be applied in loosening and tightening bolts) for the particular size man-model (1st, 5th, 50th, 95th, and 99th percentiles), posture, and tool relationship will be displayed. Strength analysis with tools is limited to torque with wrenches because this is the only tool task for which strength criteria are available in Air Force technical orders. (See Appendix D for more information on hand tools.) A limited visual analysis of tool clearance may be made when the tool has been positioned. Detailed analyses of man-model and work station interference are available with the Interference Analysis and Work Envelope functions contained in the Accessibility Analyses function menu (see Section 5).

The Materials Handling Analysis function evaluates the capabilities of the technician to lift, push, pull, hold in position, carry, or reach an object. Often these objects are the Line Replaceable Units (LRUs). In this function there is also a table displaying the 1st, 5th, 50th, 95th, and 99th percentile strength capabilities for the starting and ending positions and size and weight of the object, all of which are available to

complete the task being simulated. Currently, strength data are available for CARRY, HOLD, LIFT, PUSH AND PULL.

The Connector Analysis function evaluates the capability of the technician to attach a connector at a specified location. In this function there will also be a table of the strength capability related to grip used and size of the connector. This table displays the torque applied in inch-pounds across five percentiles (1st, 5th, 50th, 95th, and 99th).

The Maintenance Task Analyses function is initiated by selecting the TASK ANALYSIS icon from the CREW CHIEF Main Programs menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the analysis to be performed.

EXAMPLE: Select the **TASK ANALYSIS icon.**

RESULT: The CREW CHIEF Task Analyses Function menu appears (Figure 3.1).

Choose the desired analysis function by selecting the **TOOL ANALYSIS**, **MATERIALS HANDLING**, or **CONNECTOR** icon.

For a general guide to orient the man-model, see CREW CHIEF Initialization (Paragraph 2.1.2) or Quick Reference (Paragraph 8.1.1). This orientation includes standing posture, and the location of work is 24, 163.5, 0; the direction of man to work is 35, 163.5; the distance from work is 12.0; and the platform height is -20.

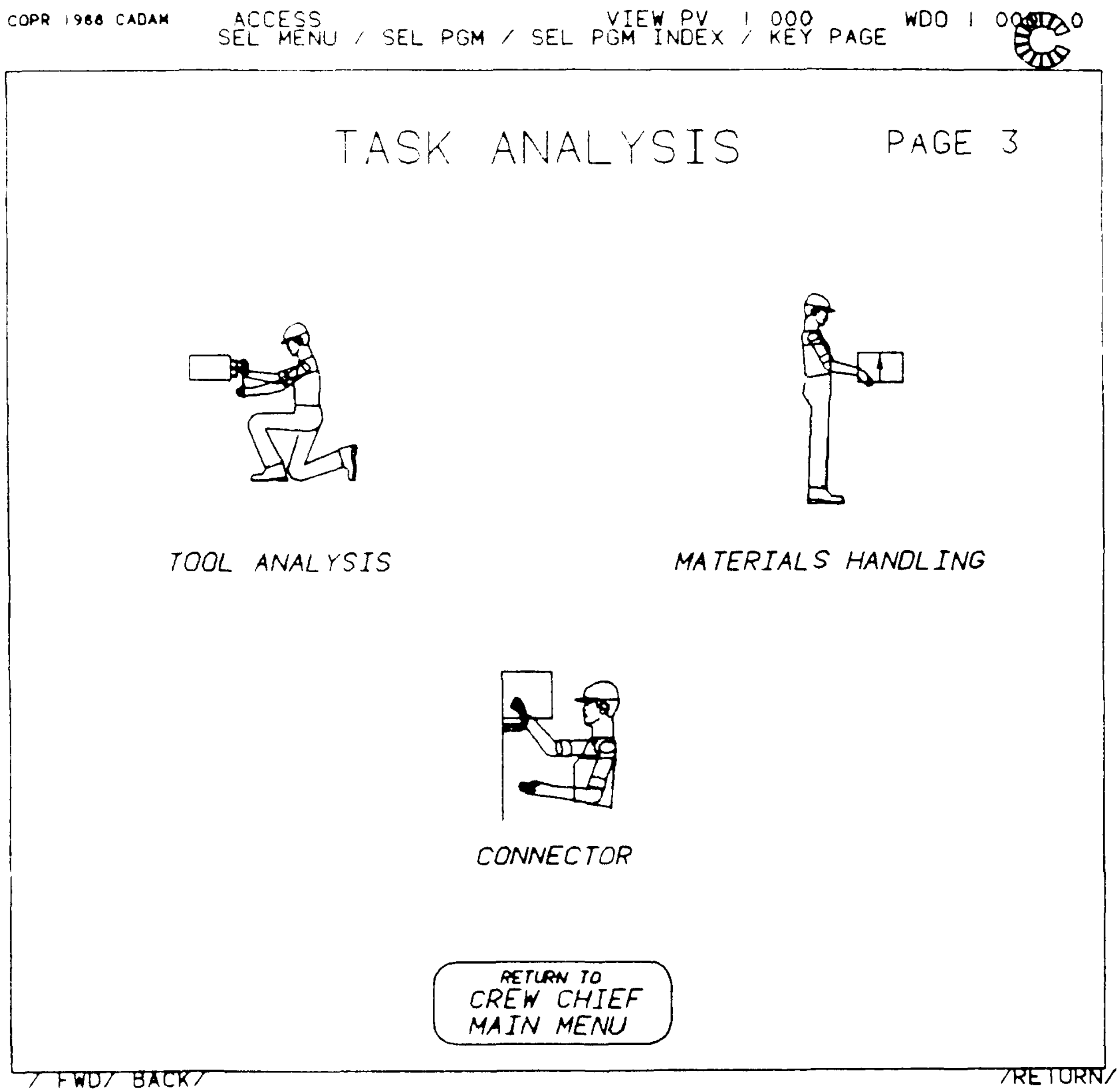


Figure 3.1. CREW CHIEF Task Analyses Function Menu.

3.1 USING THE TOOL ANALYSIS FUNCTION

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the analysis to be performed.

EXAMPLE: Select the **TOOL ANALYSIS icon.**

RESULT: The Tool Selection menu is displayed (Figure 3.2).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Tool Analysis Function .

EXAMPLE: Depress **Y/N** function key.

RESULT APPLICATION PROGRAM TANUSR EXECUTING appears and then a new prompt and menu appear.

A full description of each tool and its variations is included in Appendix D. The classifications of tools are found within the following categories and respective paragraphs: wrenches without sockets, including open end, combination wrench open end, combination wrench box end, standard box end, deep offset box end, raccheting box end, allen wrench short end and allen wrench long end (Paragraph 3.1.1); wrenches with sockets, including breaker bar, torque, ratchet, and speedhandle (Paragraph 3.1.2); screwdrivers, including flat bladed and offset (Paragraph 3.1.3); pliers (Paragraph 3.1.4); and miscellaneous tools, including nutdriver, hammer, chisel/hammer, files, scraper, hacksaw, drill, and sander (Paragraph 3.1.5).

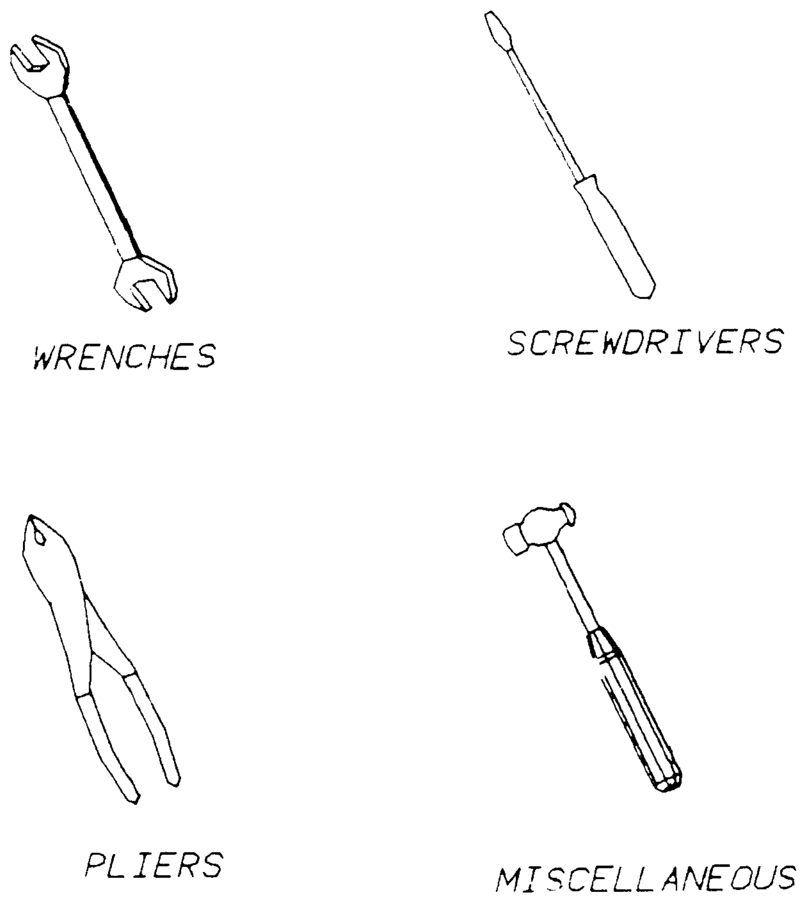


Figure 3.2. Tool Selection Menu.

3.1.1 Wrenches Without Sockets

This category of tools includes the following wrenches: open end, combination wrench open end, combination wrench box end standard box end, deep offset box end, ratcheting box end, allen wrench short end, and allen wrench long end. For this example, begin by selecting the Tool Selection menu option (see Figure 3.2) from the Task Analysis menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

ACTION: Select the type of tool to be used in the analysis.

(See Appendix D for a discussion of hand tools.)

EXAMPLE: Select **WRENCHES** .

RESULT: New prompt and menu appear.

PROMPT: SELECT WRENCHES

ACTION: Select the type of wrench to be used in the analysis (Figure 3.3).

EXAMPLE: Select **OPEN END.**

RESULT: New prompt and menu appear.

PROMPT: SELECT BOLT DIAMETER

ACTION: Select the size corresponding to the bolt diameter to be used in the analysis (Figure 3.4). The head size of the bolt is given also. This

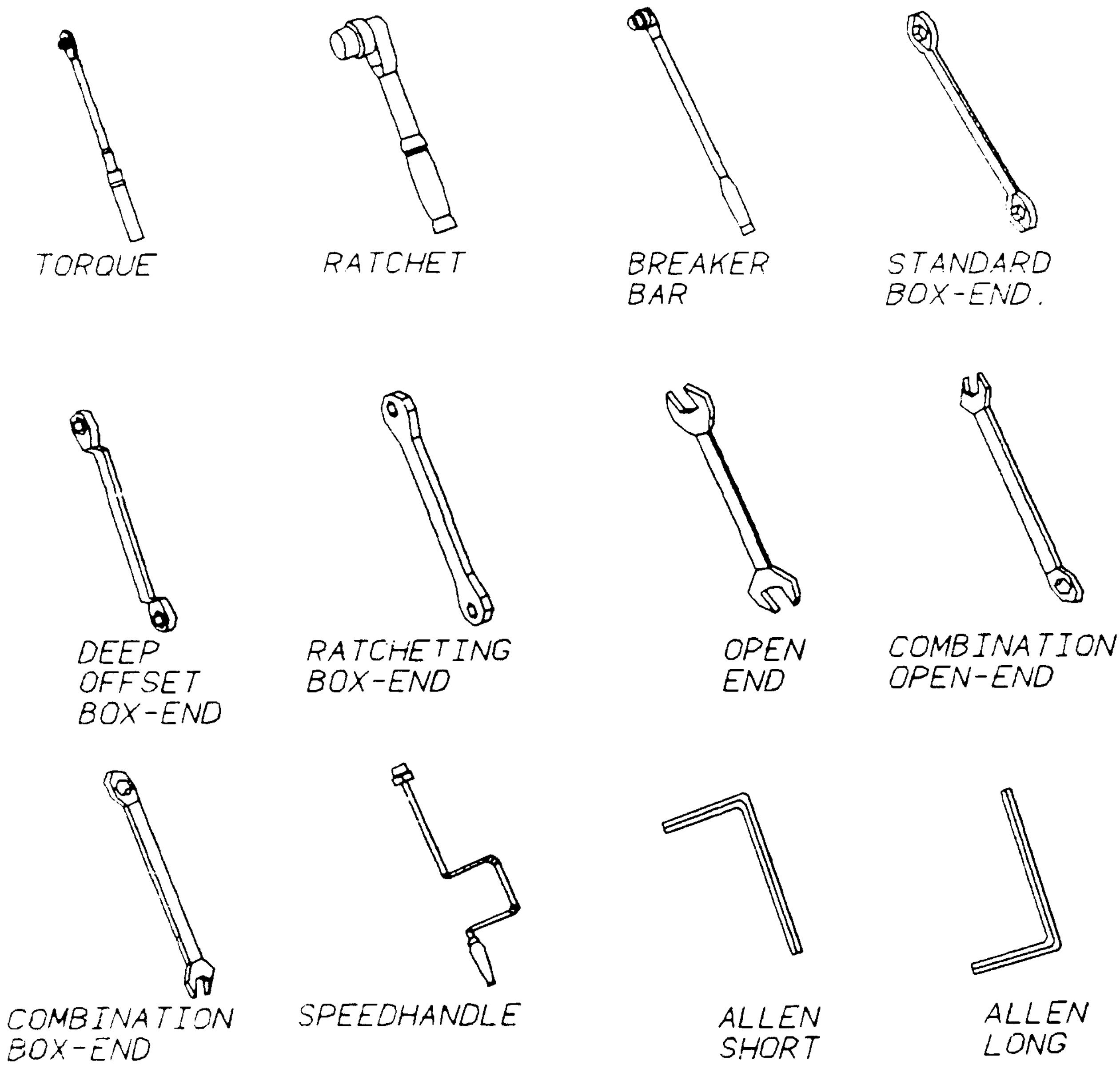


Figure 3.3. Wrench Selection Menu.

BOLT DIAM	HEAD SIZE
# 3, 4, 5	3/16
# 6, 8	1/4
# 10	5/16
3/16	3/8
1/4	7/16
5/16	1/2
3/8	9/16
7/16	5/8
1/2	3/4
9/16	13/16
5/8	15/16
3/4	1-1/4

Figure 3.4. Bolt Diameter Selection Menu for Open End Wrenches.

selection determines the size of the wrench. If one of the other wrenches without sockets is selected, different bolt diameters may be available for that particular wrench.

EXAMPLE: Select **3/16-1/4 INCH.**

RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool in the analysis (Figure 3.5). For smaller bolt diameters, right and left hand options may appear only. This is due to the fact that the size tool needed to perform this task is too small to be used with both hands.

EXAMPLE: Select **LEFT HAND.**

RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TYPE

ACTION: Select the grip type to be used in the analysis (Figure 3.6). There will be separate menus for the grip types for different tools.
EXAMPLE: Select **REVERSE**

RESULT: New prompt appears.

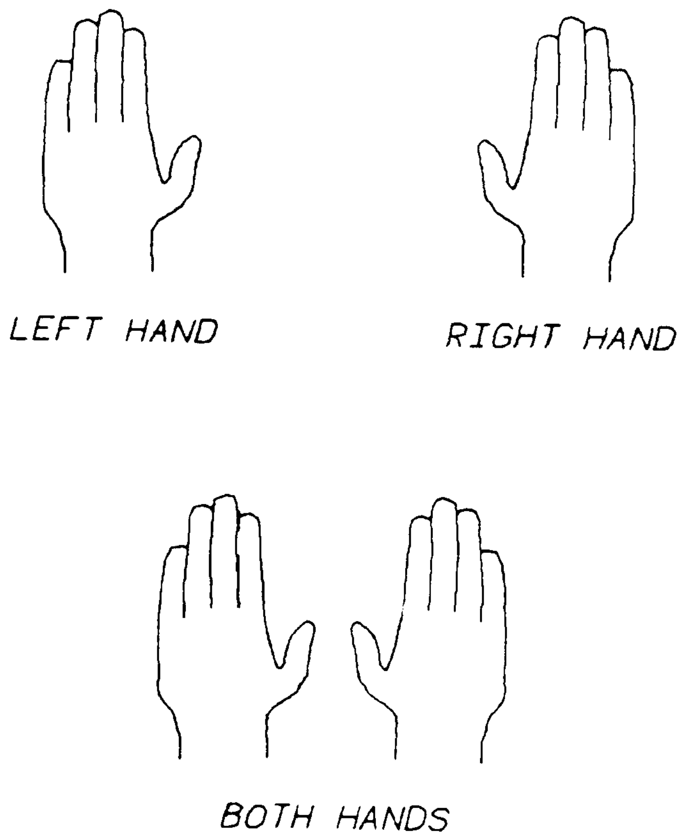


Figure 3.5. Hand Selection Menu (RIGHT HAND, LEFT HAND, and BOTH HANDS).

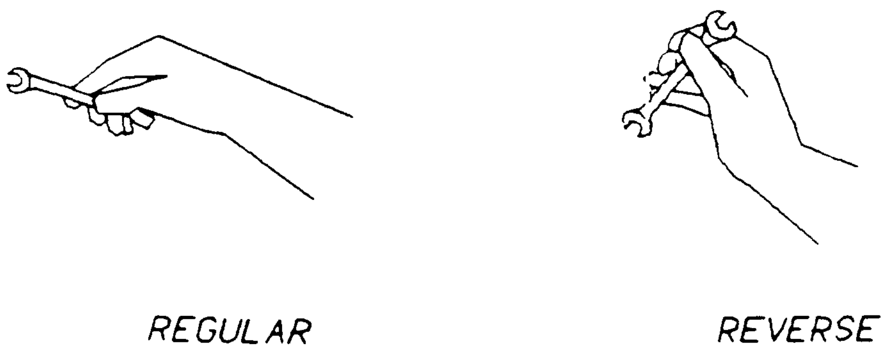


Figure 3.6. Grip Selection Menu for Open End Wrenches.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Define the location of the head point (center point of the bolt head) of the attach vector by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**.

EXAMPLE: Key in **27, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define the tail point of the attach vector (to determine orientation of the bolt axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the orientation of the bolt axis.

OR:

- Key in the X,Y,Z coordinates which define the orientation of the bolt axis **<CR>**.

EXAMPLE: Key in **35, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Define the direction that the tool handle points away from the bolt by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point in the drawing.

OR:

- Key in the X,Y,Z coordinates of the tool handle direction point **<CR>**.

EXAMPLE: Key in **35, 170, 40 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING THE TASK

ACTION: Select one of the mobility types to be used during the REACH analysis (Figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

OR:

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

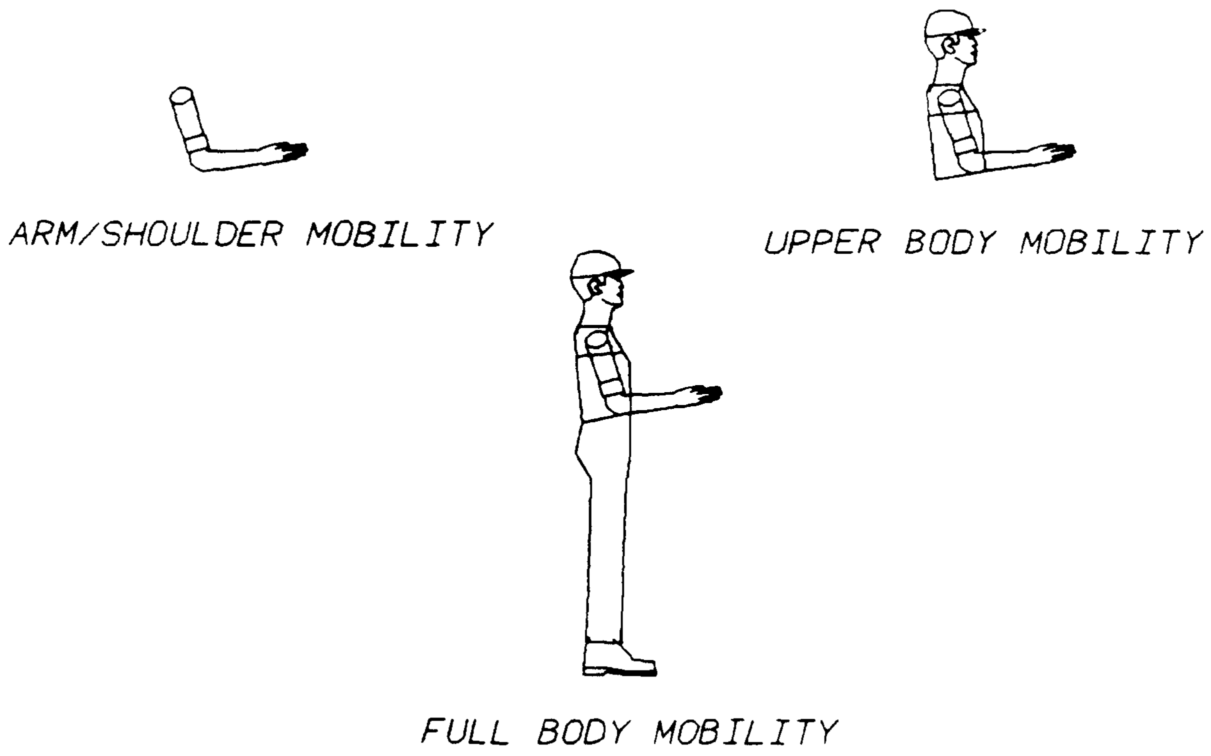


Figure 3.7. Mobility Selection Menu.

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY.**

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen. If the tool type selected is the breaker bar or the speed handle, the user is not prompted to define a center of plot point, because there are no strength-related data to be displayed.

RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand

portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.8 diagrams the flow of actions necessary to execute a tool analysis for wrenches without sockets.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another option is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.1.2 Wrenches With Sockets

This category of tools includes the following wrenches: breaker bar, torque, ratchet, and speedhandle. For this example, begin by selecting the Tool Selection menu option (see Figure 3.2) from the Task Analysis menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

ACTION: Select the type of tool to be used in the analysis. (See Appendix D for a discussion of hand tools.)

EXAMPLE: Select **WRENCHES**

RESULT: New prompt and menu appear.

PROMPT: SELECT WRENCHES

ACTION: Select the type of wrench to be used in the analysis (see Figure 3.3).

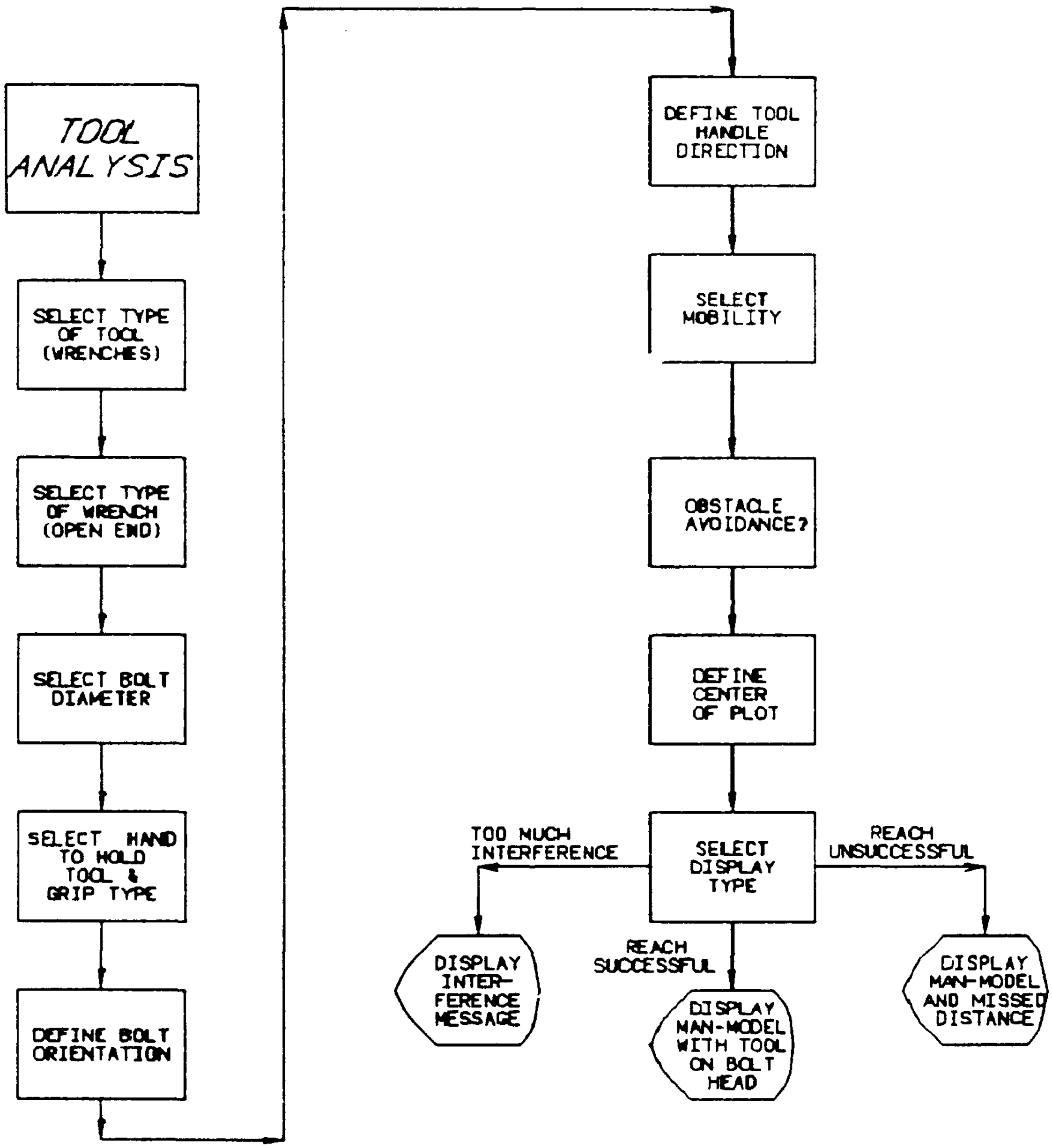


Figure 3.8. Tool Analysis Flow Diagram for Wrenches Without Sockets.

EXAMPLE: Select **RATCHET**

RESULT: New prompt and menu appear.

PROMPT: SELECT EXTENSION

ACTION: Select desired extension length (Figure 3.9). Note that no extension lengths available speedhandle.

EXAMPLE: Select **6" EXTENSION.**

RESULT: New prompt and menu appear.

PROMPT: SELECT SOCKET

ACTION: Select desired socket type (Figure 3.10).

NOTE: If the torque wrench or speedhandle is the tool type selected, then the socket type selections are:

Regular, Deep, and Hex Head. The universal joint is not included because it distorts accuracy of torque See Figure D.9 for a photograph of the various sockets

- Select **REGULAR** to display a regular socket attached to the tool.

<u>OR:</u>

- Select **DEEP** to display a socket with a deep bolt opening.

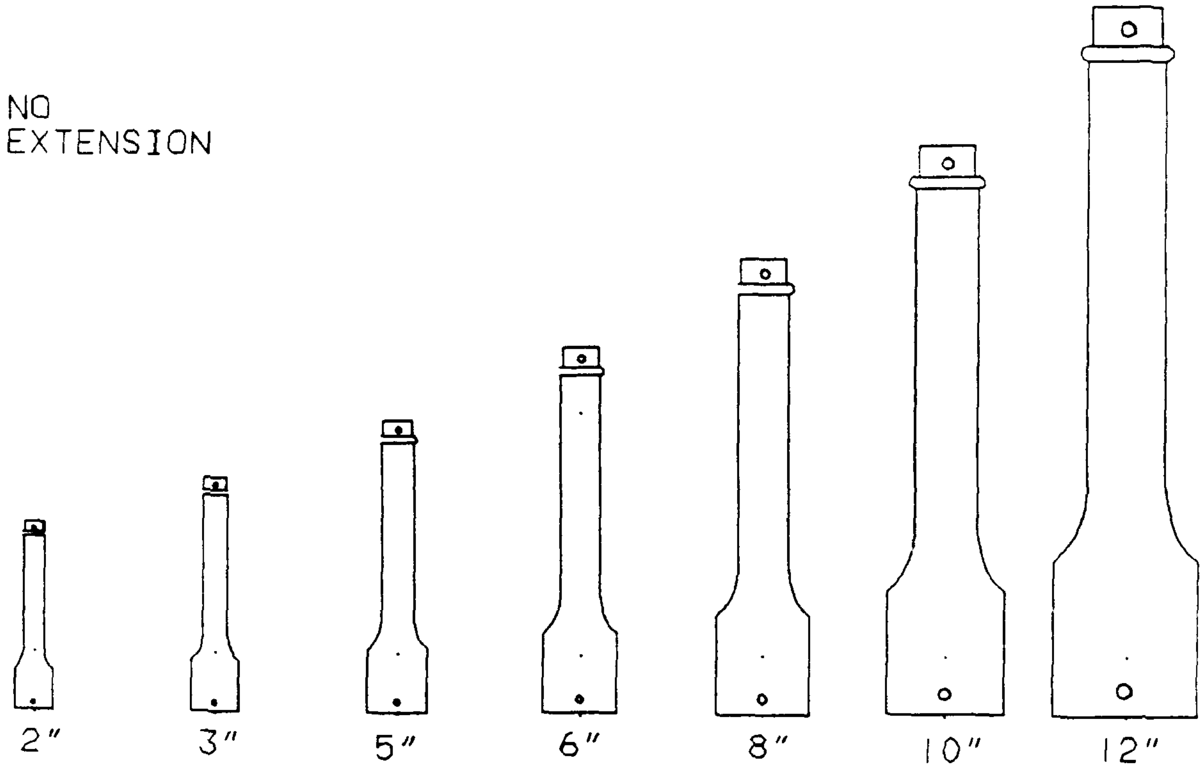


Figure 3.9. Extension Lengths Available For Wrenches With Sockets.

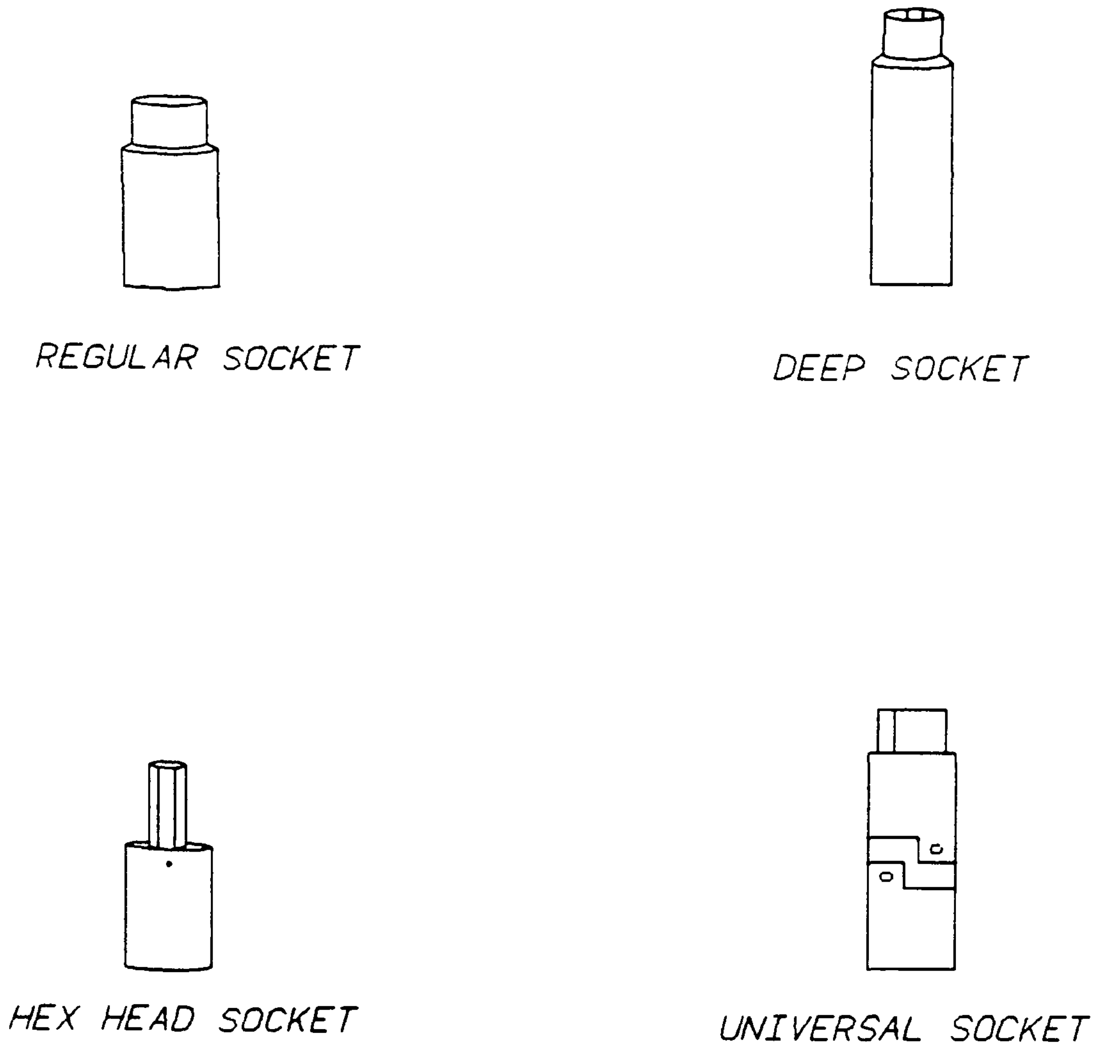


Figure 3.10. Sockets Available for Wrenches with Sockets.

OR:

- Select **HEX HEAD** to display a socket to which a six-sided prong is attached.

OR:

- Select **UNIVERSAL** to display a socket similar to a regular socket, but is hinged.

EXAMPLE: Select **REGULAR**

RESULT: New prompt and menu appear.

PROMPT: SELECT DRIVE SIZE

ACTION: Select the range corresponding to the bolt diameter to be used in the analysis (Figure 3.11). This is the diameter of the bolt threads. The drive size of the socket is also given.

EXAMPLE: Select **3/16 to 1/2 INCH** or **3/8 INCH DRIVE**.

RESULT: New prompt and menu appear.

PROMPT: SELECT HEAD SIZE

ACTION: Select the size corresponding to the head size of the bolt (Figure 3.12). The diameter of the bolt selected along with the head size of the bolt and drive of the socket determine the size of the wrench to be used in the analysis.

EXAMPLE: Select **5/16** (BOLT DIAM.) or **1/2** (HEAD SIZE).

BOLT DIAM	DRIVE SIZE
NUMBERED SCREWS 1-10	1/4" DRIVE
3/16 TO 1/2 INCH	3/8" DRIVE
> 1/2 INCH	1/2" DRIVE

Figure 3.11. Bolt Diameter Selection Menu for Ratchet Wrenches.

BOLT DIAM	HEAD SIZE
3/16	3/8
1/4	7/16
5/16	1/2
3/8	9/16
7/16	5/8
1/2	3/4

Figure 3.12. Bolt Diameter/Head Size Menu.

RESULT: New prompt and menu appear.

PROMPT: SELECT HANDLE LENGTH

ACTION: Select the length of the ratchet handle (regular or long) to be used in the analysis. This option is not available for speedhandle.

EXAMPLE: Select **LONG**

RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool in the analysis (see Figure 3.5). This option is not available for speedhandle (both hands only used).

EXAMPLE: Select **LEFT HAND.**

RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TYPE

ACTION: Select the grip type to be used in the analysis (Figure 3.13). There will be separate menus for the grip types for the different tools.

EXAMPLE: Select **REVERSE.**

RESULT: New prompt appears.

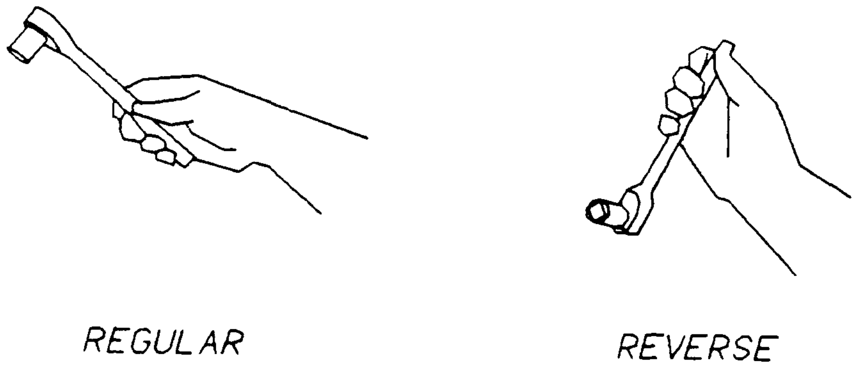


Figure 3.13. Grip Type Selection Menu for Ratchet Wrenches.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Define the location of the head point (center point of the bolt head) of the attach vector by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**.

EXAMPLE: Key in **27, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define the tail point (point which determines the bolt direction) of the attach vector (to determine the direction of the bolt axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the orientation of the bolt axis.

OR:

- Key in the X,Y,Z coordinates which define the orientation of the bolt axis **<CR>**.

EXAMPLE: Key in **35, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Define the point that determines the direction that the tool handle points away from the bolt by selecting an existing 3-D point or by keying in the X,Y,Z coordinates of the point

- Select an existing point in the drawing.

OR:

- Key in the X,Y,Z coordinates of the tool handle direction point **<CR>**.

EXAMPLE: Key in **35, 170, 40 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the reach analysis (see figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

OR:

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility .

OR:

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY.**

RESULT: New prompt and menu appear.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen. If the tool type selected is the speed handle, the user is not prompted to define a center of plot point, because there are no strength-related data to be displayed.

RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, attached to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. The strength table is also displayed for ratchet and torque wrenches. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH

INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.14 diagrams the flow of actions necessary to execute a tool analysis for wrenches with sockets.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another option is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.1.3 Screwdrivers

This classification of tools includes both flat bladed screwdrivers and offset screwdrivers. For this example, begin by selecting the Tool Selection menu option (see Figure 3.2) from the Task Analysis menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

ACTION: Select the type of tool to be used in the analysis (see Appendix D for a discussion of hand tools)

EXAMPLE: Select **SCREWDRIVER.**

RESULT: New prompt and menu appear.

PROMPT: SELECT SCREWDRIVERS

ACTION: Select the type of screwdriver to be used in the analysis (Figure 3.15).

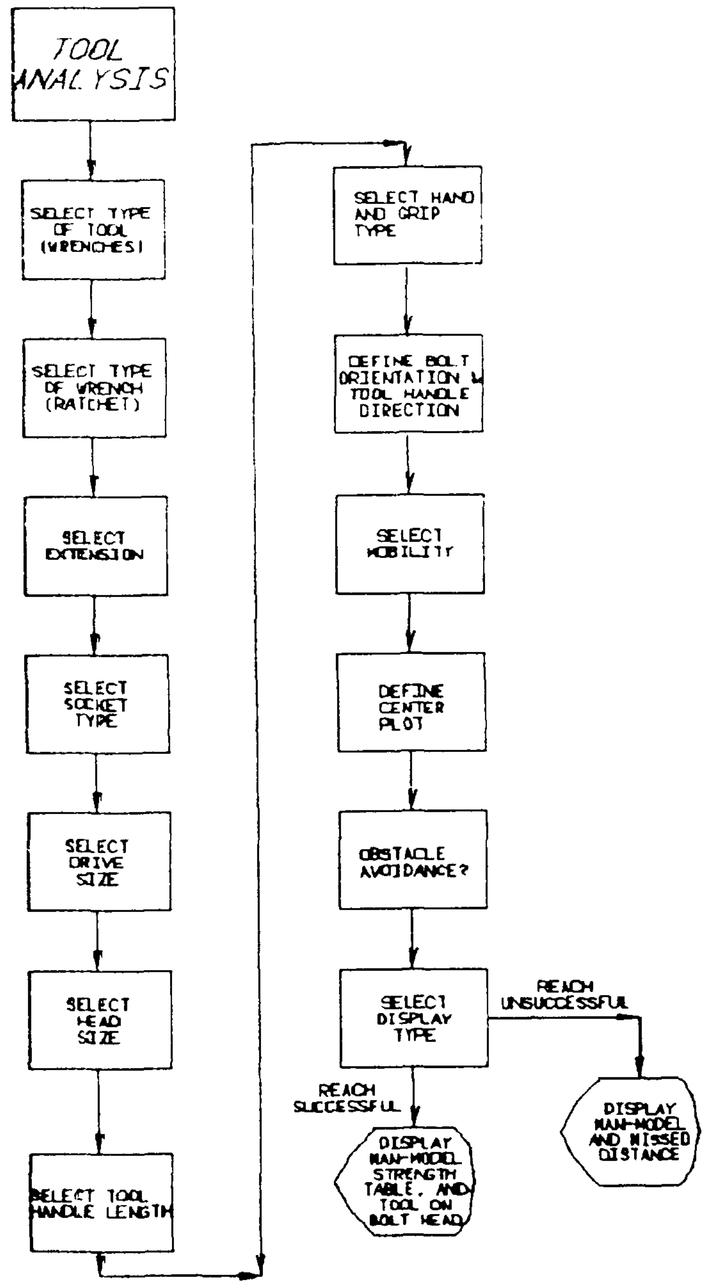


Figure 3.14. Tool Analysis Flow Diagram for Wrenches With Sockets.

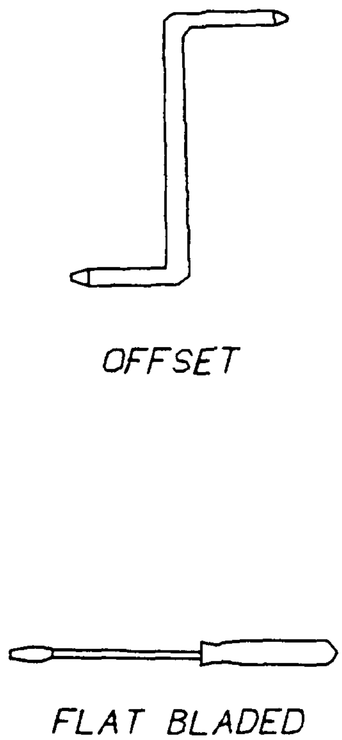


Figure 3.15. Screwdriver Selection Menu.

EXAMPLE: Select **FLAT BLADED**.

RESULT: New prompt and menu appear.

PROMPT: SELECT BLADE LENGTH

ACTION: Select the size corresponding to the screwdriver blade length to be used in the analysis (Figure 3.16). If an offset screwdriver is chosen then the choice for blade lengths would have been REGULAR or LONG.

EXAMPLE: Select **BLADE LENGTH 3.0"**.

RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool in the analysis (Figure 3.17).

EXAMPLE: Select **LEFT**.

RESULT: New prompt and menu appear.

ACTION: Select the grip type to be used in the analysis (Figure 3.18).

PROMPT: SELECT GRIP TYPE

EXAMPLE: Select **REVERSE**.

RESULT: New prompt appears.

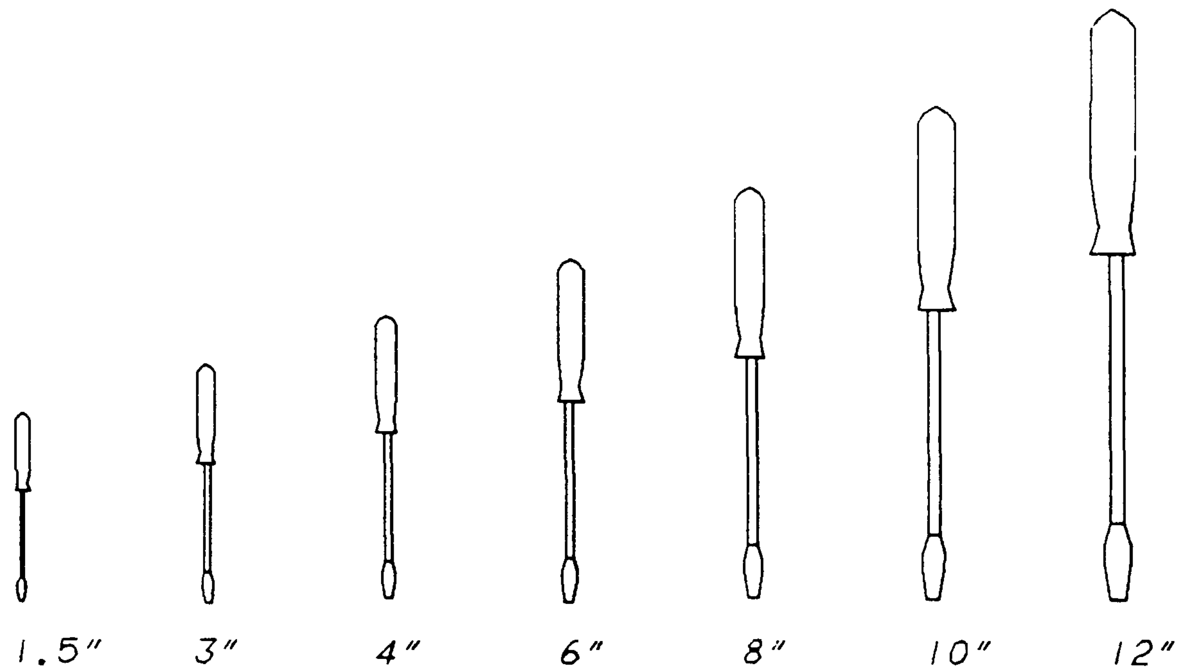


Figure 3.16. Blade Length Selection Menu.

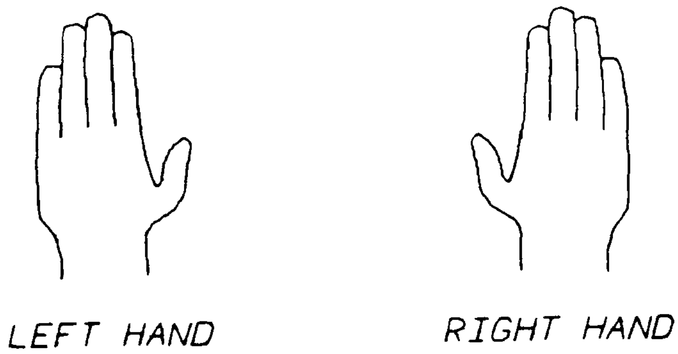


Figure 3.17. Hand Selection Menu (RIGHT HAND and LEFT HAND).

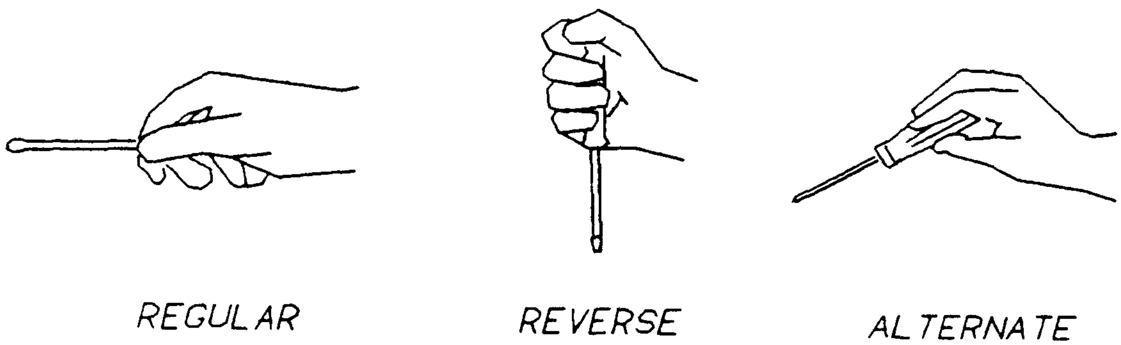


Figure 3.18. Grip Type Selection Menu for Flat Bladed Screwdrivers.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Define the location of the head point of the attach vector (screw or point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**.

EXAMPLE: Key in **27, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define the tail point of the attach vector (to determine the direction of the screw axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the orientation of the bolt axis.

OR:

- Key in the X,Y,Z coordinates which define the orientation of the screw axis **<CR>**.

EXAMPLE: Key in **35, 163, 40 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the reach analysis (see Figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

<u>OR:</u>

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

<u>OR:</u>

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY.**

RESULT: New prompt and menu appears.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance; execution time is increased.

<u>OR:</u>

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance during REACH analysis.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears at top of the window. If the reach is unsuccessful because the distance between the man- model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because

there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.19 diagrams the flow of actions necessary to execute a tool analysis for flat bladed screwdrivers.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another option is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.1.4 Pliers

This category of tools includes the following pliers: combination, needle nose, safety wire, adjustable joint, and wire cutters. Since all types of pliers follow the same sequence of prompts to define their orientation in the work space, the combination pliers will be used as an example. For this example, begin by selecting the Tool Selection menu (see Figure 3.2) from the Task Analysis Menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

ACTION: Select the type of tool to be used in the analysis (see Appendix D for a discussion of hand tools).

EXAMPLE: Select **PLIERS**.

RESULT: New prompt and menu appear.

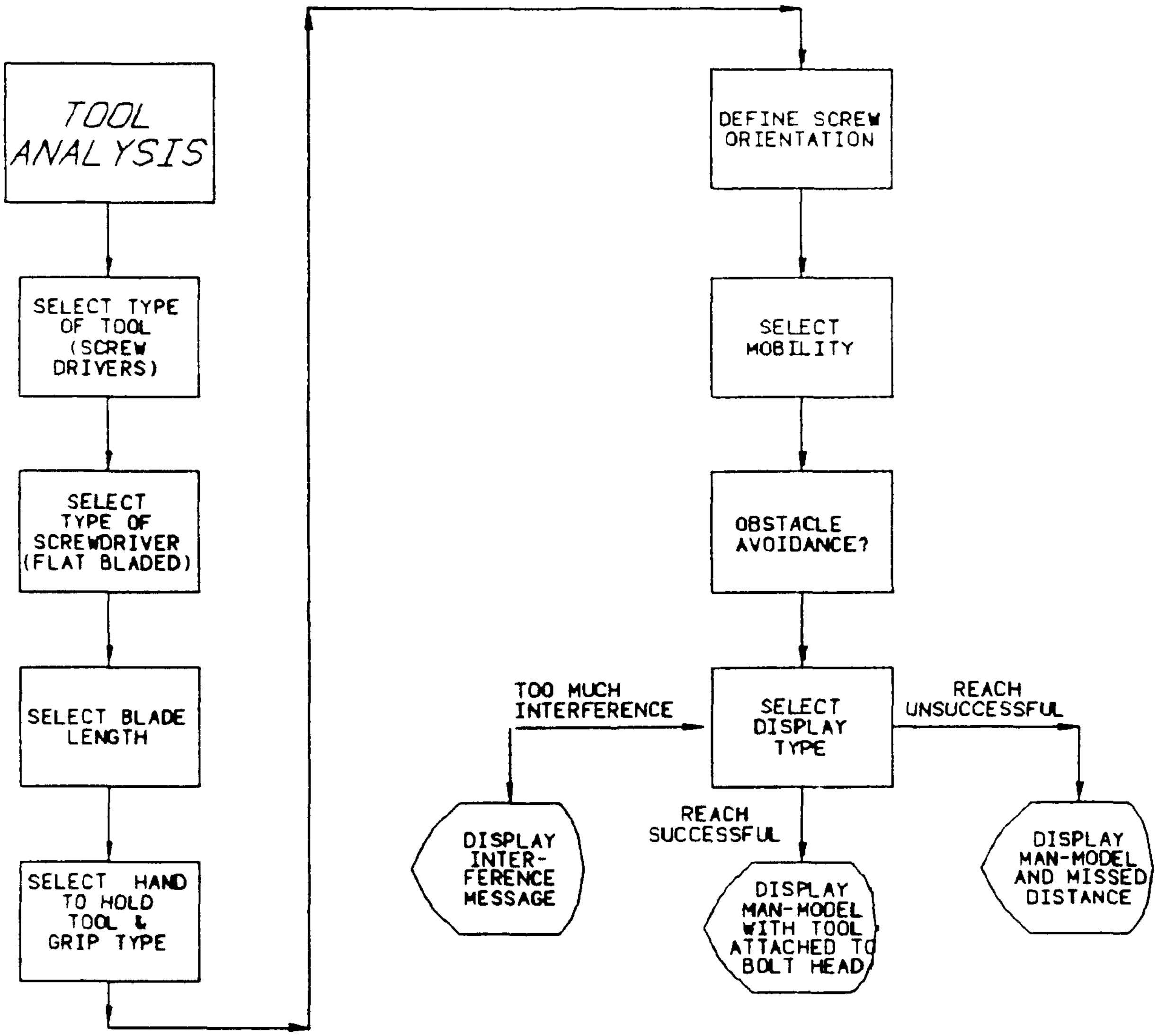


Figure 3.19. Tool Analysis Flow Diagram for Flat Bladed Screwdrivers.

PROMPT: SELECT PLIERS

ACTION: Select the type of pliers to be used in the analysis (Figure 3.20).

EXAMPLE: Select **COMBINATION.**

RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool in the analysis (see Figure 3.17).

EXAMPLE: Select **LEFT HAND.**

RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TYPE

ACTION: Select the grip type to be used in the analysis (Figure 3.21). There will be separate menus for different pliers.

EXAMPLE: Select **REGULAR.**

RESULT: New prompt and menu appear.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Define the location of the head point of the attach vector (point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

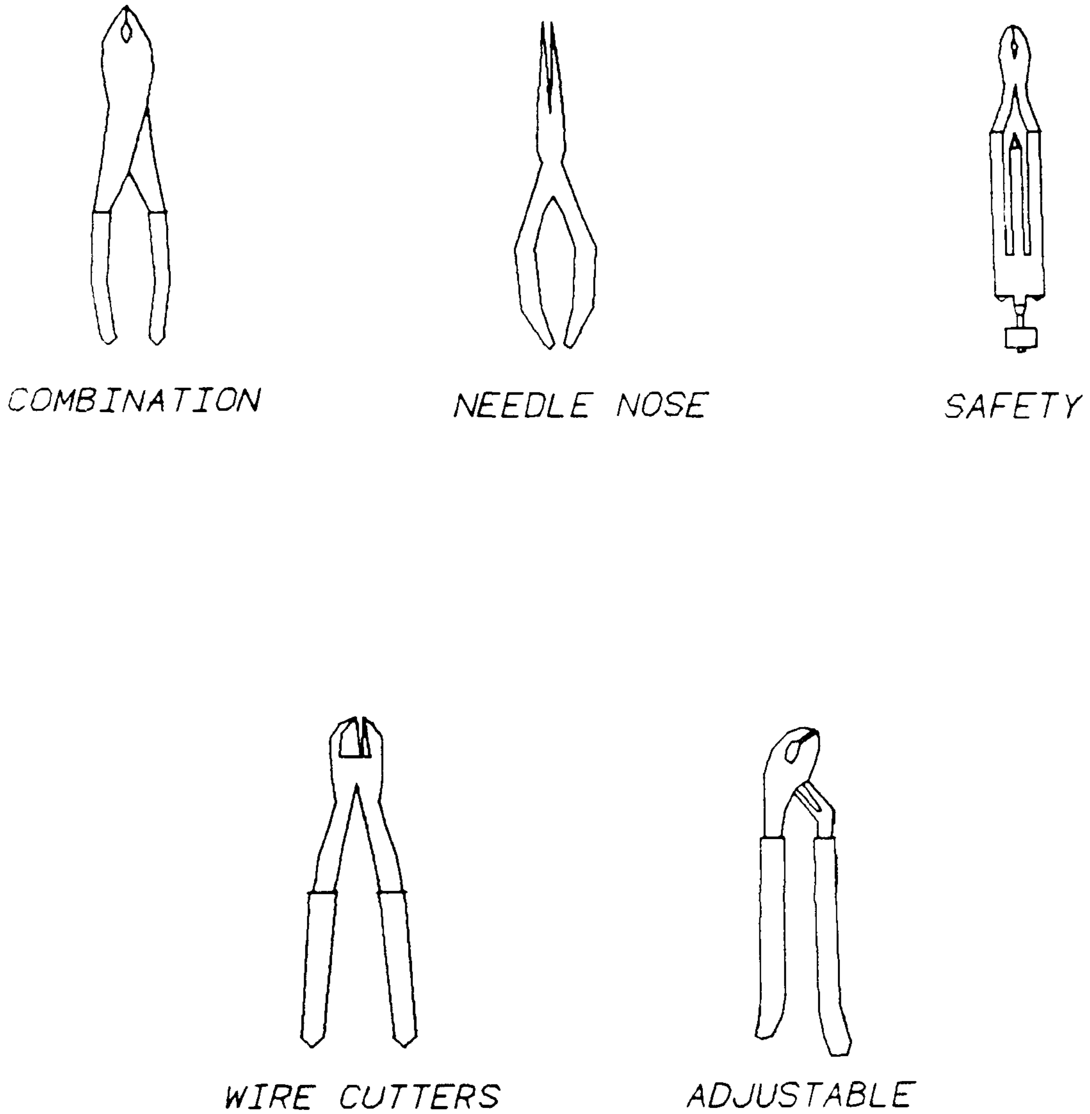
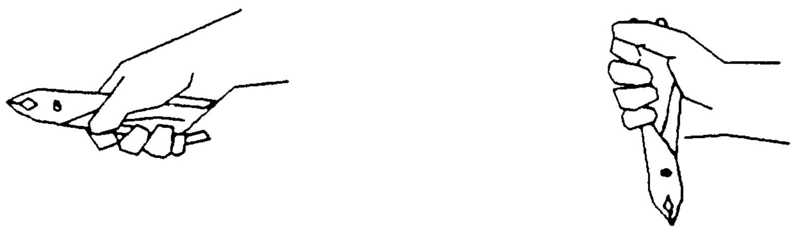


Figure 3.20. Pliers Selection Menu.



REGULAR REVERSE

Figure 3.21. Grip Type Selection Menu for Combination Pliers.

- Select an existing 3-D point to define the location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**.

EXAMPLE: Key in **27, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define the tail point of the attach vector (to determine the direction of the point of attachment axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the tail point of attach vector.

OR:

- Key in the X,Y,Z coordinates which define the tail point of attach vector **<CR>**.

EXAMPLE: Key in **35, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Define the direction that the tool handle points away from the point of attachment.

- Select an existing point in the drawing.

OR:

- Key in the X,Y,Z coordinates of the tool handle direction point <CR>.

EXAMPLE: Key in **35, 170, 40 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the reach analysis (see Figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

OR:

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the obstacle avoidance choices .

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.22 diagrams the flow of actions necessary to execute a tool analysis for pliers.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another option is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.1.5 Miscellaneous Tools

This classification of tools includes the following: hammer, chisel/hammer, file, scraper, hacksaw, drill, nutdriver and sander. For this example, begin by selecting the Tool Selection menu (see Figure 3.2) from the Task Analysis menu (see Figure 3.1).

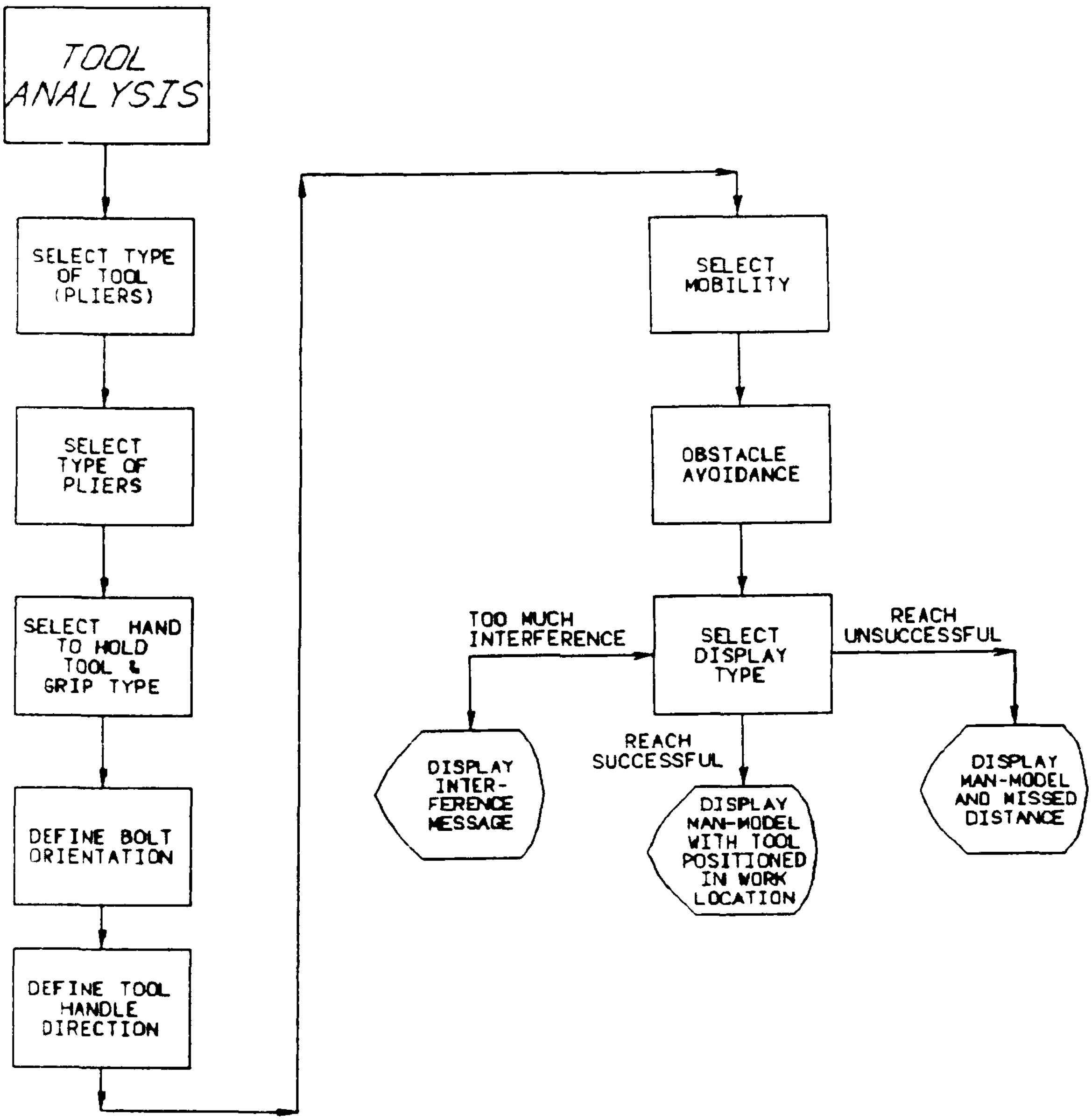


Figure 3.22. Tool Analysis Flow Diagram for Pliers.

PROMPT: SELECT TOOL CLASS

ACTION: Select the type of tool to be used in the analysis (see Figure 3.2). (See Appendix D for a discussion of hand tools.)

EXAMPLE: Select **MISCELLANEOUS**.

RESULT: New prompt and a new menu appear.

PROMPT: SELECT MISCELLANEOUS TOOLS

ACTION: Select the type of miscellaneous tool to be used (Figure 3.23).

EXAMPLE: Select **HAMMER**.

REUSLT: New prompt and menu appear.

If the tool select had been a NUTDRIVER, then the user would be prompted to SELECT BOLT DIAMETER and to SELECT GRIP TYPE. The prompt SELECT CHISEL is only for the selection of a hammer. As a result of choosing of HAMMER the user receives the following prompt.

PROMPT: SELECT CHISEL

ACTION: Select to include chisel or not to include chisel.

EXAMPLE: Select **NO CHISEL**.

RESULT: New prompt and menu appear.

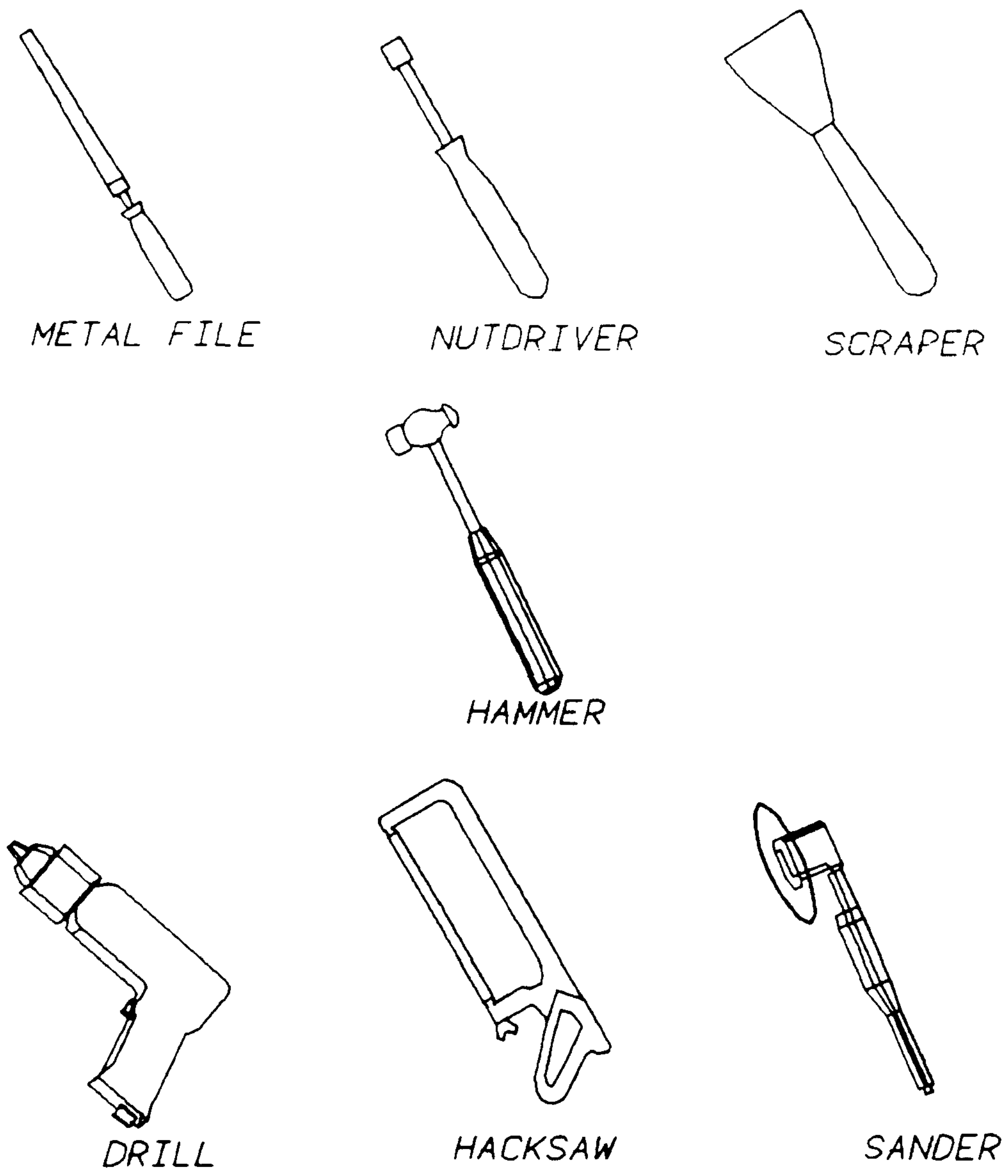


Figure 3.23. Miscellaneous Tool Selection Menu.

PROMPT: SELECT HAND TO BE USED DURING TASK

ACTION: Select in which hand the tool will be positioned (see Figure 3.17). If hammer, nutdriver, hacksaw, drill or scraper is the tool selected for the analysis, it may be placed in either the right hand or in the left hand. No selection for hand to hold tool is given for the file or sander because both hands are automatically used for both.

EXAMPLE: Select **RIGHT HAND** .

RESULT: New prompt appears.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Define the location of the head point of the attach vector (point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**.

EXAMPLE: Key in **27, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define the tail point of attach vector (to determine the direction of the point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the tail point of attach vector.

<u>OR:</u>

- Key in the X,Y,Z coordinates which define the tail point of attach vector **<CR>**.

EXAMPLE: Key in **35, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Define the direction that the tool handle points away from the point of attachment. The tool handle direction is needed only for the hammer, scraper, hacksaw, drill, and sander. If the file or nutdriver had been selected then this prompt would not have appeared.

- Select an existing point in the drawing.

<u>OR:</u>

- Key in the X,Y,Z coordinates of the tool handle direction point **<CR>**.

EXAMPLE: Key in **35, 170, 40 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING ANALYSIS

ACTION: Select one of the mobility types to be used during the REACH analysis.

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

OR:

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY.**

RESULT: New prompt and menu appear.

]PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME.**

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-and the point of attachment

is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.24 diagrams the flow of actions necessary to execute a tool analysis for all Miscellaneous Tools.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another option is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2 MATERIALS HANDLING ANALYSIS FUNCTION

This function will be used for analysis pertaining to the handling of objects in the workplace. The function will consider such factors as the ability to do one- and two-handed reaches to an object, and strength capabilities related to lift, move, and position of objects in the location of work relative to the man-model's position and posture, and to the location of the object in the workplace.

To use the Materials Handling function, have the CREW CHIEF Main Programs menu activated (see Figure 1.3). Selecting the TASK ANALYSIS icon causes the CREW CHIEF Task Analysis Function menu to appear (see Figure 3.1).

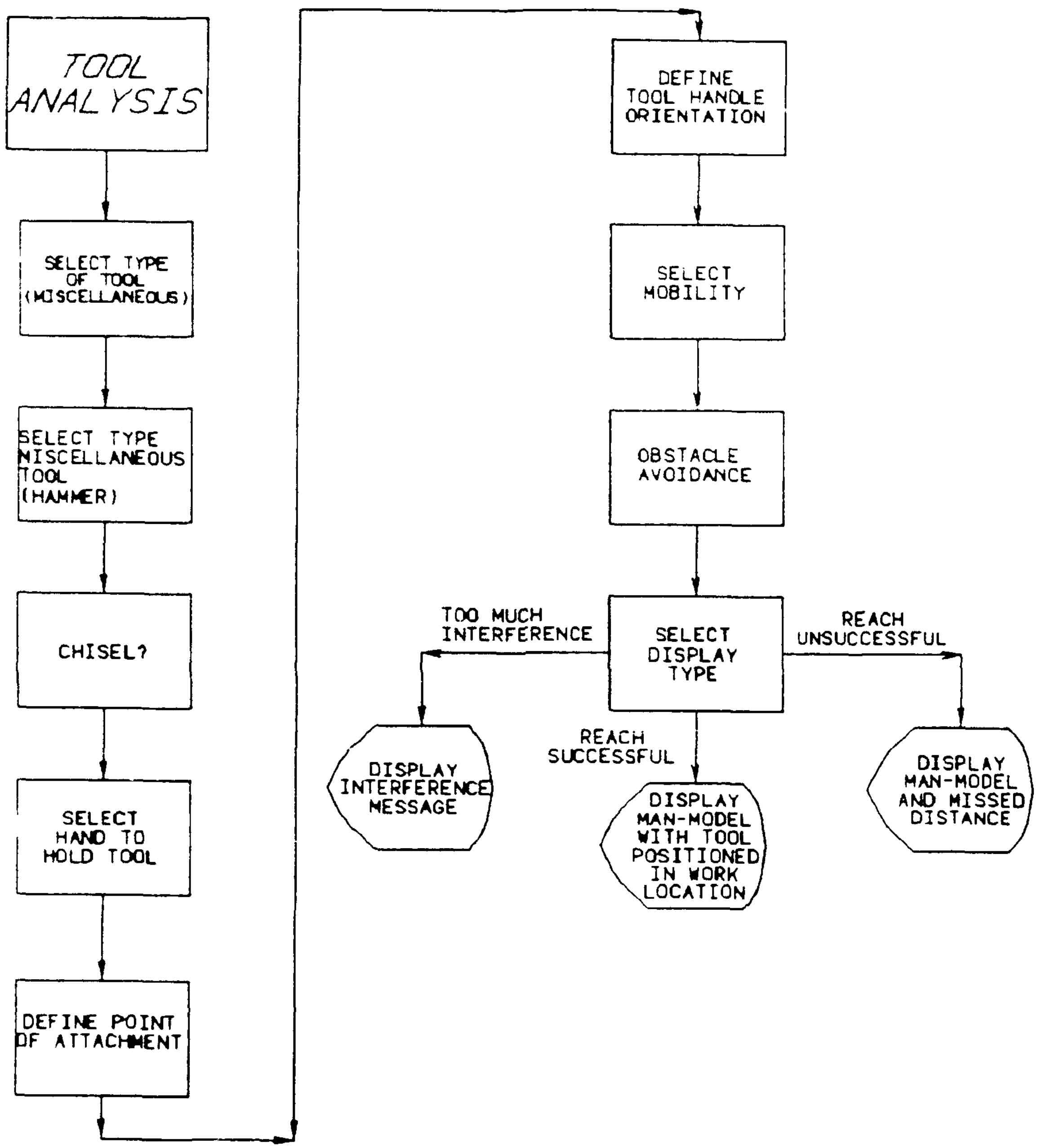


Figure 3.24. Tool Analysis Flow Diagram for Miscellaneous Tools.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the Task Analysis function to be performed (see Figure 3.1).

EXAMPLE: Select the **MATERIALS HANDLING icon.**

RESULT: The Materials Handling Task menu is displayed (Figure 3.25).

3.2.1 <u>CARRY</u>

CARRY is the first of the six materials handl.. tasks and is selected when the man-model transports an object while supporting the object's weight from one horizontal location to another. For this example, begin by selecting the Materials Handling Task menu (Figure 3.25) from the Task Analysis menu (see Figure 3.1).

Note that the CARRY Task will automatically change the current man-model posture based on the input ceiling height.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the name of the task to use for the analysis (see Figure 3.25).

EXAMPLE: Select the **CARRY icon.**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

ACTION: Depress the **Y/N** function key to execute the Carry Task.

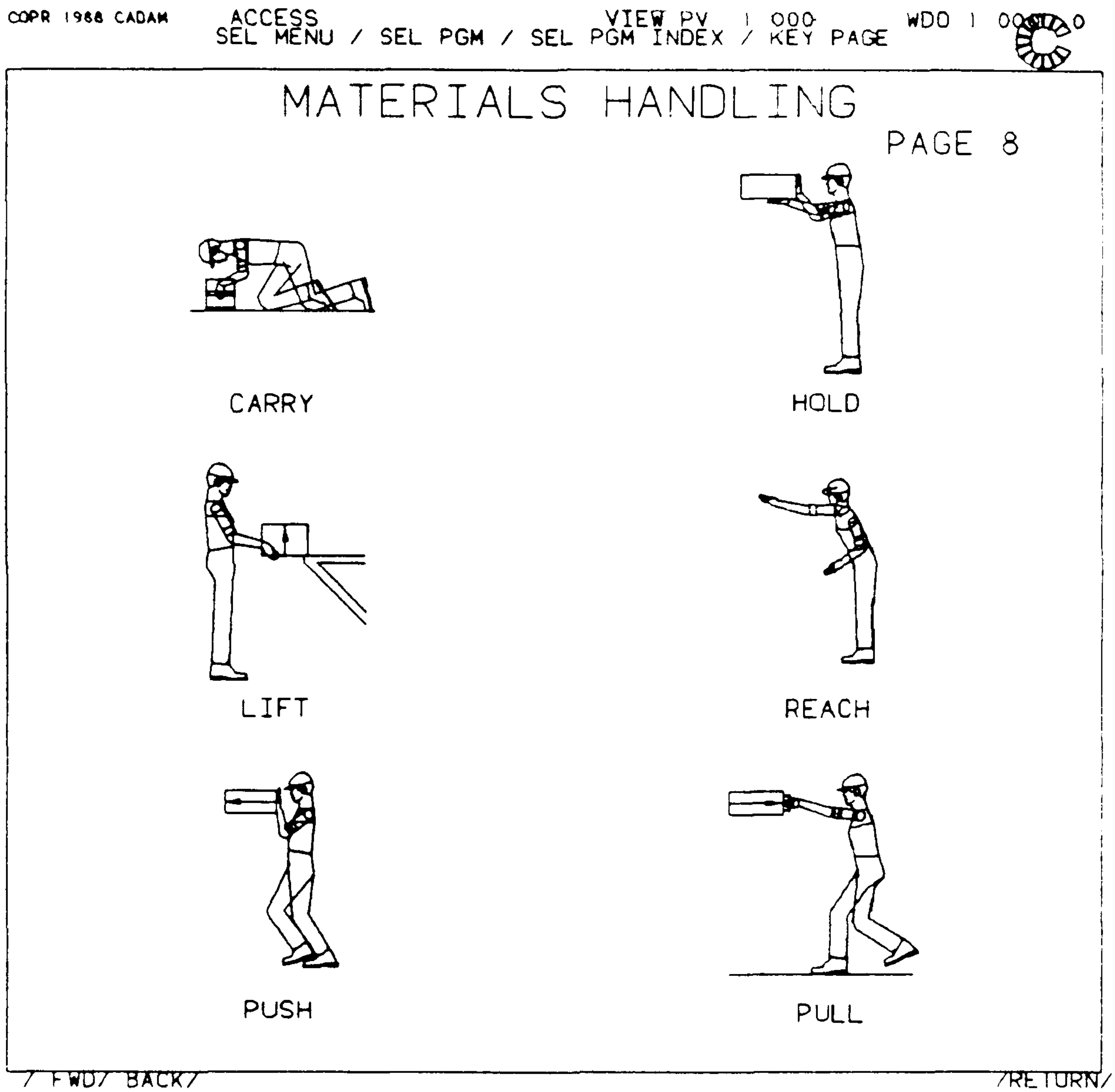


Figure 3.25. Materials Handling Tasks Menu.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM CRYUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select one of the handle choices to determine whether or not handles will be used (Figure 3.26).

- Select **NO HANDLES** to indicate that no handles are to be used during the CARRY task.

OR:

- Select **ONE HANDLE** to indicate that one handle is to be used during the CARRY task. The man-model will only perform CARRY Tasks with handles when the ceiling height is below 50 percent of the current man-model stature.

OR:

- Select **TWO HANDLES** to indicate that two handles are to be used during the CARRY task. The man-model will only perform CARRY Tasks with handles when the ceiling height is below 50 percent of the current man-model stature.

EXAMPLE: Select **NO HANDLES**.

RESULT: New prompt and menu appear.

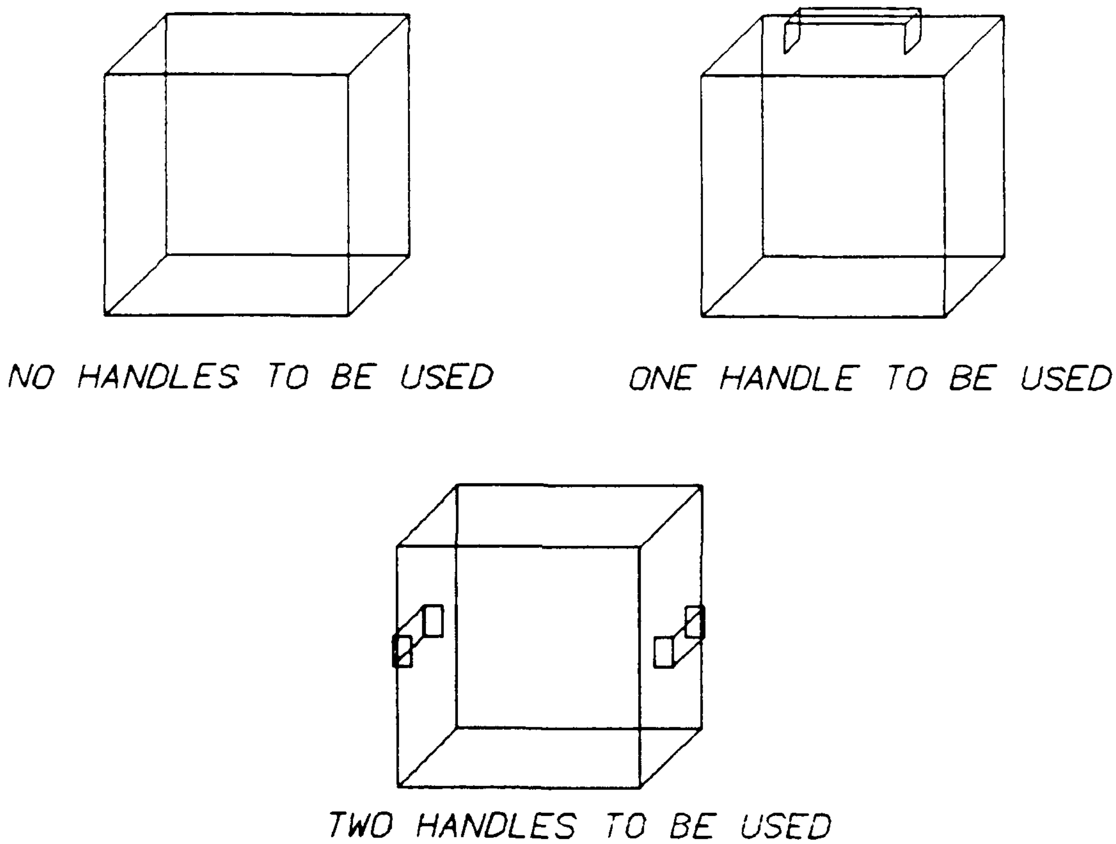


Figure 3.26. Handles Selection Menu (NO HANDLES, ONE HANDLE, and TWO HANDLES).

If ONE HANDLE had been chosen, the user would next be prompted to SELECT ARM TO BE USED DURING TASK. As a result of selecting NO HANDLES, the following prompt appears.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR CEILING DEFINITION

ACTION: Select the mode for defining the ceiling height.

- Choose **SELECT ELEMENT TO DETERMINE CEILING HEIGHT** to allow selection of an element from the screen.

OR:

- Choose **KEY IN CEILING HEIGHT** to allow the ceiling height to be entered at the ANKB.

EXAMPLE: Select **KEY IN CEILING HEIGHT.**

RESULT: New prompt appears.

If SELECT ELEMENT TO DETERMINE CEILING HEIGHT is chosen, the user would be prompted to SELECT CEILING HEIGHT from the screen. As a result of selecting **KEY IN CEILING HEIGHT**, as the example, the following prompt will appear on the screen.

PROMPT: KEY IN CEILING HEIGHT

ACTION: Key in value to represent ceiling height **<CR>**.

EXAMPLE: Key in **80 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in a value to represent the height of the object to be carried **<CR>**.

EXAMPLE: Key in **12.34 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in a value to represent the width of the object to be carried **<CR>**.

EXAMPLE: Key in **20.2 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in a value to represent the depth of the object to be carried **<CR>**.

EXAMPLE: Key in **18 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach.

RESULT: A new prompt appears.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **OBSTACLE AVOIDANCE** to include obstacle avoidance during CARRY analysis; execution time is increased.

OR:

- Select **NO OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **NO OBSTACLE AVOIDANCE.**

RESULT: Prompt remains the same, but new bottom menu appears.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definition of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to carry the object successfully, the man-model appears superimposed in the drawing as a wire-frame model holding the object in the final CARRY position, with its hands either on the object or on the handle(s). A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand corner of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.27 diagrams the flow of actions necessary to execute a CARRY analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2.2 HOLD

HOLD is the second of the six materials handling tasks, and is selected when the man-model supports the weight of an object at a required height. For this example, begin by selecting the Materials Handling Task menu (see Figure 3.25) from the Task Analysis menu (see Figure 3.1).

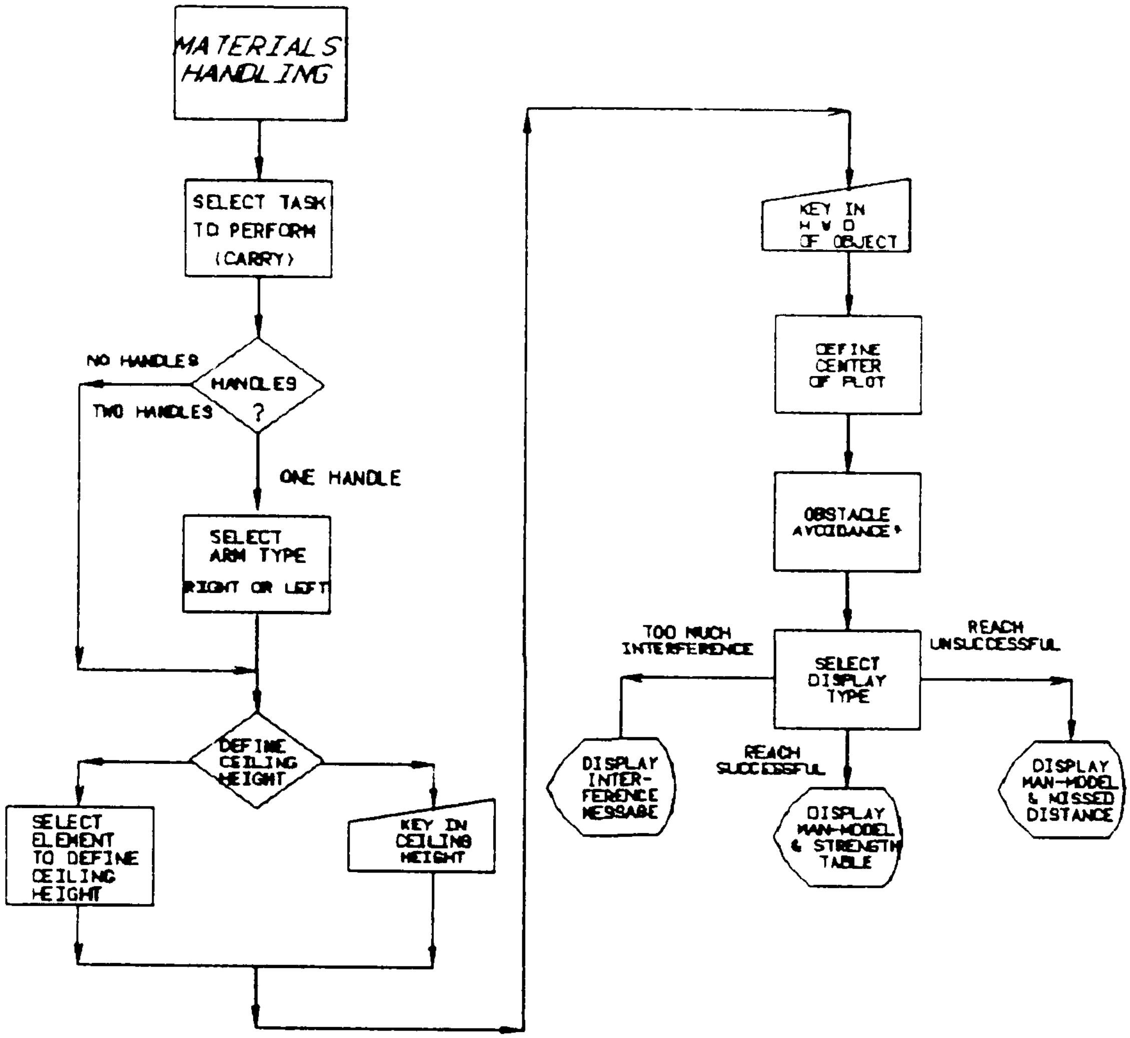


Figure 3.27. Materials Handling Analysis Flow Diagram for CARRY Task.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the name of the task to use for the analysis (see Figure 3.25).

EXAMPLE: Select the **HOLD icon.**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

ACTION: Depress the **Y/N** function key to execute the Hold Task.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM HLDUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT ARM TO BE USED DURING TASK

ACTION: Select which arm will hold the object in the analysis (Figure 3.28).

EXAMPLE: Select **RIGHT ARM.**

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select mobility type to be used during the reach analysis (see Figure 3.7).

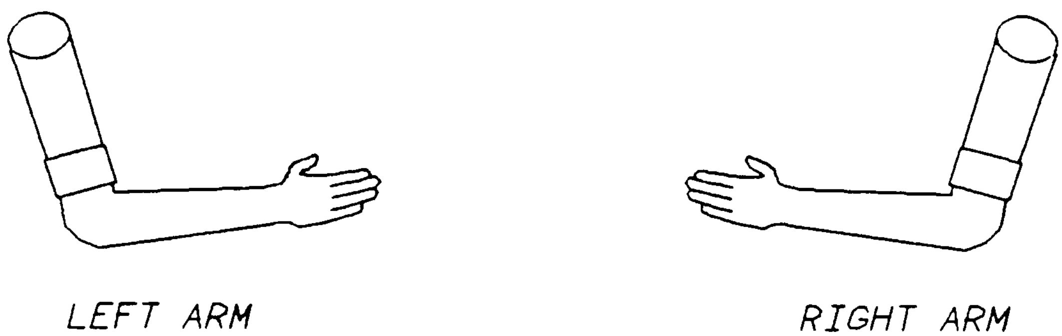


Figure 3.28. Arm Selection menu (RIGHT ARM and LEFT ARM).

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **FULL BODY.**

RESULT: New prompt and menu appear.

PROMPT: SELECT TYPE OF SUPPORT OBJECT IS TO BE HELD AGAINST

ACTION: Select Hold Task Type to be used.

EXAMPLE: Select **HOLD AGAINST WALL.**

RESULT: New prompt and menu appear.

If HOLD AGAINST CEILING is chosen as the type of support, the user would select a mode for defining the object (KEY IN or SELECT). Choosing HOLD AGAINST CEILING also automatically defines the top of the object as the ceiling height (see Paragraph ?.2.1). As a result of selecting **HOLD AGAINST WALL** the following prompts will appear on the screen.

PROMPT: SELECT TYPE OF BARRIER INVOLVED IN HOLD TASK

ACTION: Select one of the barrier types. This action will affect the strength values output at the completion of a successful task.

- Select **NO BARRIER INVOLVED** to indicate a task which does not involve any obstructions which would keep the man-model from reaching in any direction or which would require the man-model to bend over due to obstacles.

OR:

- Select **VERTICAL BARRIER BETWEEN OBJECT AND CREW CHIEF** to indicate man-model will stand approximately 15 inches or more away from the object due to obstacles in the man-model's reach path.

OR:

- Select **CEILING BARRIER CAUSED UNUSUAL POSTURE DURING TASK** to indicate an overhead barrier. This barrier will cause the man-model to bend over to complete the task.

EXAMPLE: Select **CEILING BARRIER.**

RESULT: New prompt appears.

If NO BARRIER or VERTICAL BARRIER is chosen, the user would be prompted to select the mode for defining the object (KEY IN or SELECT). (See Paragraph 8.2.2.2.) As a result of selecting a **CEILING BARRIER**, the following prompt will appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR CEILING DEFINITION

ACTION: Select the mode for defining ceiling height.

- Choose **SELECT ELEMENT TO DETERMINE CEILING HEIGHT** to indicate that a line segment will be selected to define the ceiling height.

<u>OR:</u>

- Select **KEY IN CEILING HEIGHT** to indicate the ceiling height will be keyed in.

EXAMPLE: Choose **SELECT ELEMENT TO DETERMINE CEILING HEIGHT.**

RESULT: New prompt and menu appear.

If the user selects KEY IN CEILING HEIGHT, the user is prompted to KEY IN THE CEILING HEIGHT. As a result of choosing **SELECT CEILING HEIGHT**, the following prompt appears.

PROMPT: SELECT ELEMENT TO DEFINE CEILING HEIGHT

ACTION: Select a line segment in the drawing to define the ceiling height. The line segment selected will be used to define the ceiling height by taking the intersection of the line segment (which is extended as needed to find an intersection) with the plane that bisects the man-model into symmetric right and left halves. The vertical distance between this intersection point and the platform becomes the value of the ceiling height. Note that it is possible that no intersection can be found and the user will be notified later. EXAMPLE: Select a line segment which defines the ceiling height.

RESULT: A new prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select the mode (key in or select) for defining the dimensions (HEIGHT, WIDTH, and DEPTH) of the object to be held.

- Choose **SELECT OBJECT FROM SCREEN** to allow selection of elements from screen. The height and width selections will determine the attach plane and attach points of the object automatically for objects held AGAINST WALL. Similarly, the width and depth selection will determine the attach plane (i.e., CEILING) and attach points for objects held AGAINST CEILING.

<u>OR:</u>

- Choose **KEY IN OBJECT DIMENSIONS** to allow dimensions to be entered at the ANKB.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS.**

RESULT: New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH. When these other elements have been defined, the user would select END from the bottom menu (see Paragraph 8.2.2.2). If the user selects **KEY IN OBJECT DIMENSIONS**, as in the example, the following prompt will appear on the screen.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in a value to represent the height of the object to be held **<CR>**.

EXAMPLE: Key in **10.31 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in a value representing the width of the object to be held **<CR>**.

EXAMPLE: Key in **15 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in a value representing the depth of the object to be held **<CR>**.

EXAMPLE: Key in **9.5 <CR>**.

RESULT: New prompt appears.

PROMPT: SELECT LINE DEFINING HEIGHT DIRECTION OF OBJECT

ACTION: Select an element from the screen which will be used to define the plane to which the object will be attached. Since the example uses AGAINST WALL, the user must select a line which extends in the same direction as the height of the object.

RESULT: New prompt appears.

PROMPT: SELECT LINE DEFINING WIDTH DIRECTION OF OBJECT

ACTION: Select element from screen which will be used to define the plane to which the object will be attached. Since this example is for an AGAINST WALL, the user should select a line which lies on the wall (or mounting bracket). This line should not lie in the same direction as the line selected for the previous prompt. These lines determine an attach plane for the created object. The back face of the object will be placed flush against the plane (or a parallel plane) defined by these two lines. Note that this determines the directions of the width and depth dimensions of the object since the height direction has already been defined and the object is assumed rectilinear. (All dimensions are assumed to be perpendicular to each other.)

RESULT: New prompt appears.

PROMPT: DEFINE ATTACH POINT OF THE OBJECT ON PLANE OF ATTACHMENT

ACTION: Define a 3-D point to indicate where the center of the back face of the object will be placed on the attach plane (wall or bracket the object is to be held against).

- Select an existing 3-D point from the screen to determine the attach point of the object.

<u>OR:</u>

- Key in the X,Y,Z coordinates **<CR>** to determine which face of the object will be attached to the attach plane.

EXAMPLE: Key in **110.37, 25.80, 15.45 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach.

RESULT: A new prompt appears.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **DO NOT PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to hold the object successfully, the man-model appears superimposed in the drawing as a wire-frame model holding the object with its hands either on the object or on the handle(s) (in the final hold position). A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great or because there are barriers present, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS

INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand corner of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.29 diagrams the flow of actions necessary to execute a HOLD analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2.3 LIFT

LIFT is the third of the six materials handling tasks, and is selected when the man-model transports an object from one vertical location to another. For this example, begin by selecting the Materials Handling Task menu (see Figure 3.25) from the Task Analysis menu (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the name of the task to use for the analysis (see Figure 3.25).

EXAMPLE: Select the **LIFT icon.**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

ACTION: Depress the **Y/N** function key to execute the Lift Task.

EXAMPLE: Depress the **Y/N** function key.

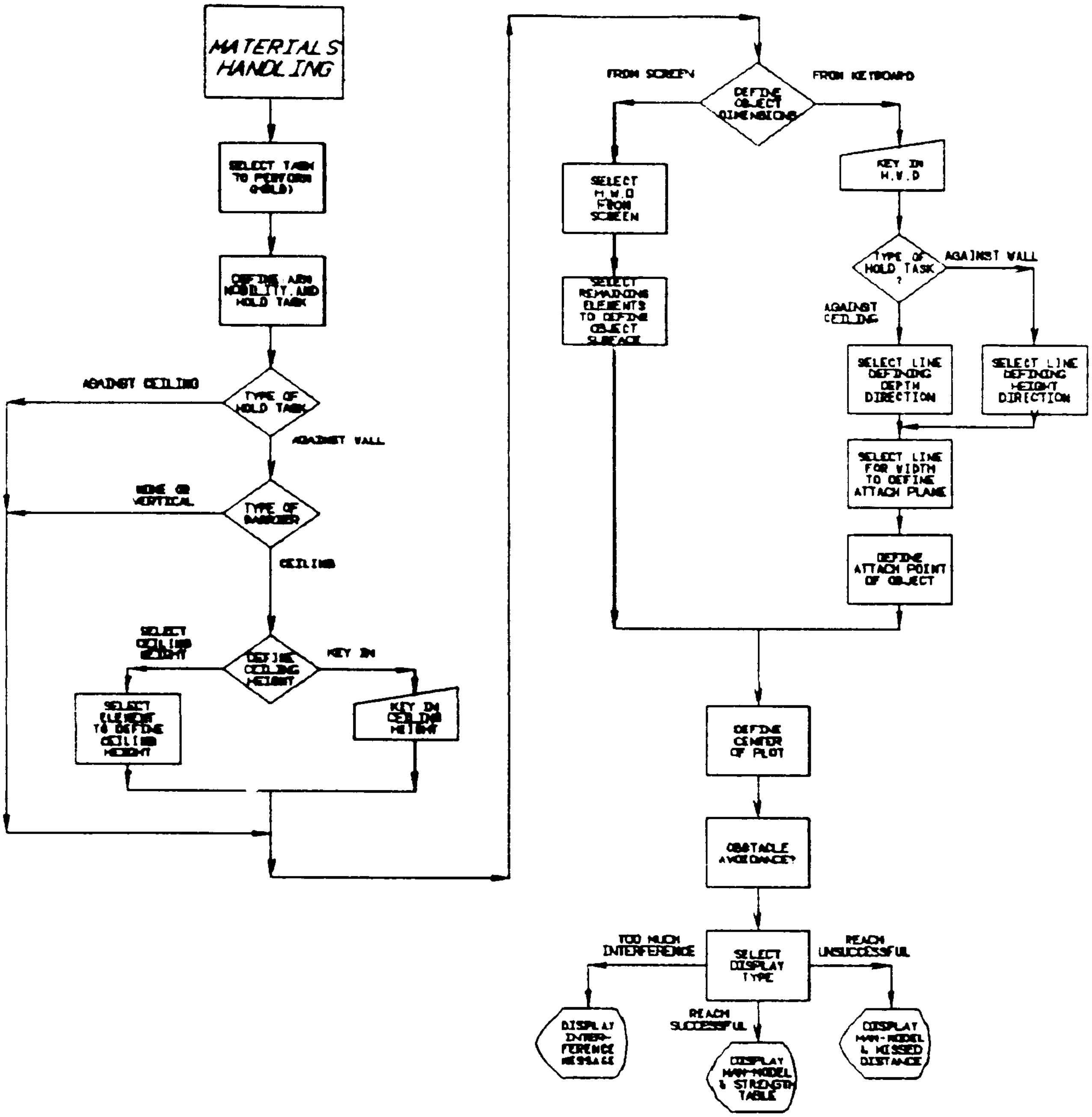


Figure 3.29. Materials Handling Analysis Flow Diagram for HOLD Task.

RESULT: APPLICATION PROGRAM LFTUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select number of handles to be used during the lift task (Figure 3.30). Currently, the Lift task does not have data to support a TWO HAND, ONE HANDLE lift combination.

EXAMPLE: Select **ONE HANDLE**.

RESULT: New prompt and menu appear.

If NO HANDLES was selected as the example, the user would not be prompted to SELECT ARM TO BE USED DURING TASK. The program assumes both arms will be used to lift the object. By selecting **ONE HANDLE** the user would receive the following prompt.

PROMPT: SELECT ARM TO BE USED DURING TASK

ACTION: Select which arm will lift the object in the analysis (see Figure 3.28).

EXAMPLE: Select **RIGHT ARM.**

RESULT: New prompt and menu appear.

PROMPT: **SELECT** MOBILITY TO BE USED DURING THE TASK

ACTION: Select mobility type to be used during the reach analysis (see Figure 3.7).

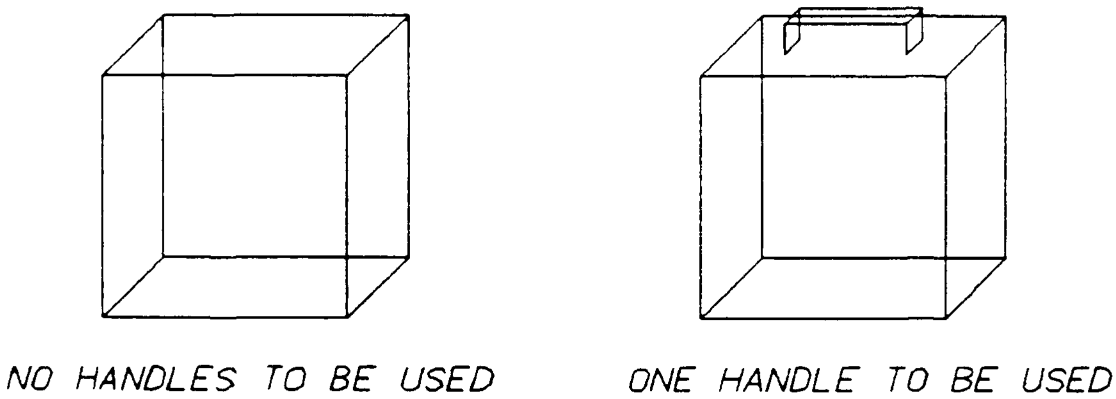


Figure 3.30. Handle Selection (NO HANDLES and ONE HANDLE).

- Select UPPER BODY to allow movement from waist up; includes arm/shoulder mobility.

<u>OR:</u>

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

<u>OR:</u>

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **FULL BODY**.

RESULT: New prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select the mode (key in or select) for defining the dimensions (HEIGHT, WIDTH, and DEPTH) of the object to be lifted.

- Choose **SELECT OBJECT FROM SCREEN** to allow selection of elements from screen.

<u>OR:</u>

- Choose **KEY IN OBJECT DIMENSIONS** to allow dimensions to be entered at the ANKB.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS**.

RESULT: New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH. When these other elements have been defined, the user would select END from the bottom menu. These elements define an irregularly shaped object. If the user had chosen ONE HANDLE, he would then be prompted to DEFINE FIRST ENDPOINT OF HANDLE and DEFINE SECOND ENDPOINT OF FIRST HANDLE. (See Paragraph 8.2.2.3.) If a handle is chosen and the object dimensions are keyed-in, the handle will automatically be placed on top of the object by the program. If the user selects **KEY IN OBJECT DIMENSIONS**, as in the example, the following prompt will appear on the screen.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in a value representing the height of the object to be lifted **<CR>**.

EXAMPLE: Key in **12 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in a value to represent the width of the object to be lifted **<CR>**.

EXAMPLE: Key in **10.7 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in a value representing the depth of the object to be lifted **<CR>**.

EXAMPLE: Key in **5.34 <CR>**.

RESULT: New prompt appears.

PROMPT: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR OBJECT

ACTION: Select mode for defining the lift distance. This distance is the vertical distance from the man-model's support plane to the final lift height.

- Choose **KEY IN OBJECT DISTANCES** to enter value on ANKB. This value is the final lift height of the object.

OR:

- Choose **SELECT LINE TO DEFINE OBJECT DISTANCES** to select an element on the screen which will be the shelf onto which the object will be lifted. This shelf is the final lift height of the object.

EXAMPLE: Select **KEY IN OBJECT DISTANCES.**

RESULT: New prompt appears.

PROMPT: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

ACTION: Key in the vertical distance to lift the object.

EXAMPLE: Key in **20 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

ACTION: Key in the horizontal distance to lift the object. This value represents the distance from the man-model to the front edge of the object.

EXAMPLE: Key in **15 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach.

RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during reach analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used for shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME.**

RESULT: If the man-model is able to lift the object successfully, the man-model appears superimposed in the drawing as a wire-frame model lifting the object with hands either on the object or on the handles. A strength table is also displayed. A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand

corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.31 diagrams the flow of actions necessary to execute a LIFT analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2.4 PUSH

PUSH is the fourth of the six materials handling tasks, and is selected when the man-model moves an object away from the man-model in a horizontal direction without supporting the weight of the object. The Push task is always performed with both hands. For this example, begin by selecting Materials Handling Task menu (see Figure 3.25) from the Task Analysis menu (see Figure 3.1)

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the name of the task to use for the analysis (see Figure 3.25).

EXAMPLE: Select the **PUSH icon.**

RESULT: New prompt appears.

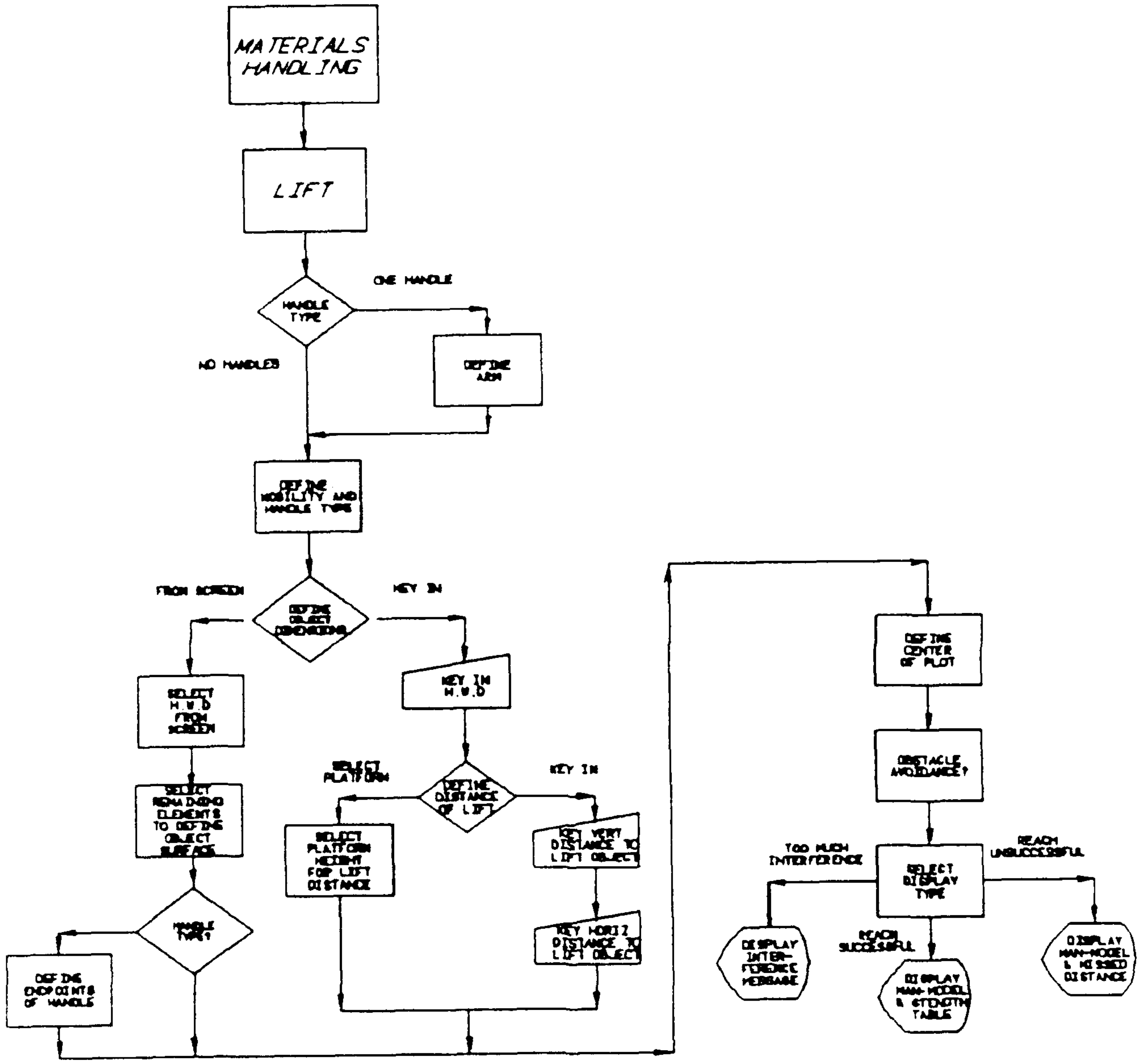


Figure 3.31. Materials Handling Analysis Flow Diagram for LIFT Task.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

ACTION: Depress the **Y/N** function key to execute the Push Task.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM PSHUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING THE TASK

ACTION: Select mobility type to be used during the reach analysis (see Figure 3.7).

- Select UPPER BODY to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **FULL BODY**.

RESULT: New prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select handle type to be used (Figure 3.32).

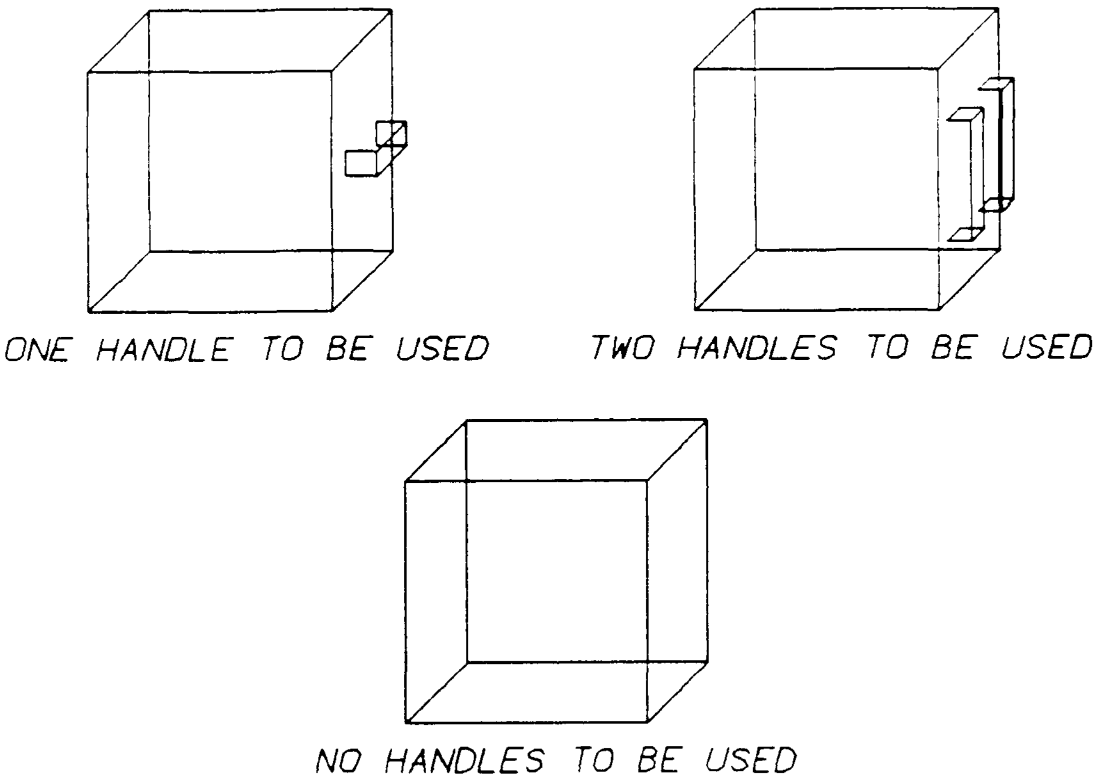


Figure 3.32. Handle Selection Menu (NO HANDLES, ONE HANDLE, and TWO HANDLES).

EXAMPLE: Select **ONE HANDLE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select whether you wish to key in values to define the object dimensions, or if you wish to select elements from the screen to define the object dimensions. If you choose to select elements from the screen, only straight lines and two-point splines are recognized as valid elements.

- Choose **SELECT OBJECT FROM SCREEN** if the object dimensions are to be defined by selecting screen elements.

OR:

- Select **KEY IN OBJECT DIMENSIONS** if the object dimensions are to be defined by keying in values.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS.**

RESULT: New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH. When these other elements have been defined, the user would select END from the bottom menu. These elements define an irregularly shaped object. If the user had chosen a handle(s), he would then be prompted to DEFINE FIRST ENDPOINT OF HANDLE(s) and to DEFINE SECOND ENDPOINT TWO OF HANDLE(s). (See

Paragraph 8.2.2.3.) If a handle(s) is chosen and the object dimensions are keyed-in, the handle(s) will automatically be placed on top of the object by the program. If the user selects **KEY IN OBJECT DIMENSIONS**, as in the example, the following prompt will appear on the screen.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in a value **<CR>** to define the height of the object.

EXAMPLE: Key in **10.3 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in a value **<CR>** to define the width of the object.

EXAMPLE: Key in **12.0 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in a value **<CR>** to define the depth of the object.

EXAMPLE: Key in **12.0 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR OBJECT

ACTION: Select whether you wish to key in values to define the shelf height and distance of push, or if you wish to select an element from the screen to define these distances.

- Choose **SELECT LINE TO DEFINE OBJECT DISTANCES** if the push distances are to be defined by selecting an element from the screen.

OR:

- Choose **KEY IN OBJECT DISTANCES** if the push distances are to be defined by keying in values.

EXAMPLE: Select **KEY IN OBJECT DISTANCES.**

RESULT: New prompt appears.

PROMPT: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

ACTION: Key in a value **<CR>** to define the vertical distance for the push.

EXAMPLE: Key in **45.0 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

ACTION: Key in a value **<CR>** to define the horizontal push distance.

EXAMPLE: Key in **20.5 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN COEFFICIENT OF FRICTION

ACTION: Key in a value **<CR>** to define the coefficient of friction between the man-model's shoes and the surface on which he is standing for this analysis. For description of values, see Figure 7.3 [HELP page].

EXAMPLE: Key in **0.47 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MENU WHICH IDENTIFIES THE NEED FOR OBJECT CLEARANCE

ACTION: Select the type of object clearance desired in this analysis. Object clearance is the space between the object and the inner surfaces of the containing area.

- Choose **CLEARANCE IS CRITICAL** if the object has a tight clearance.

OR:

- Choose **CLEARANCE NOT CRITICAL** if the object will easily clear the area into which it will be placed.

EXAMPLE: Select **CLEARANCE IS NOT CRITICAL.**

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach.

RESULT: New prompt and new menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during reach analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **DO NOT PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading

<u>OR:</u>

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to push the object successfully, the man-model appears superimposed in the drawing as a wire-frame model pushing the object with his hands either on the object or on the handles. A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.33 diagrams the flow of actions necessary to execute a PUSH analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

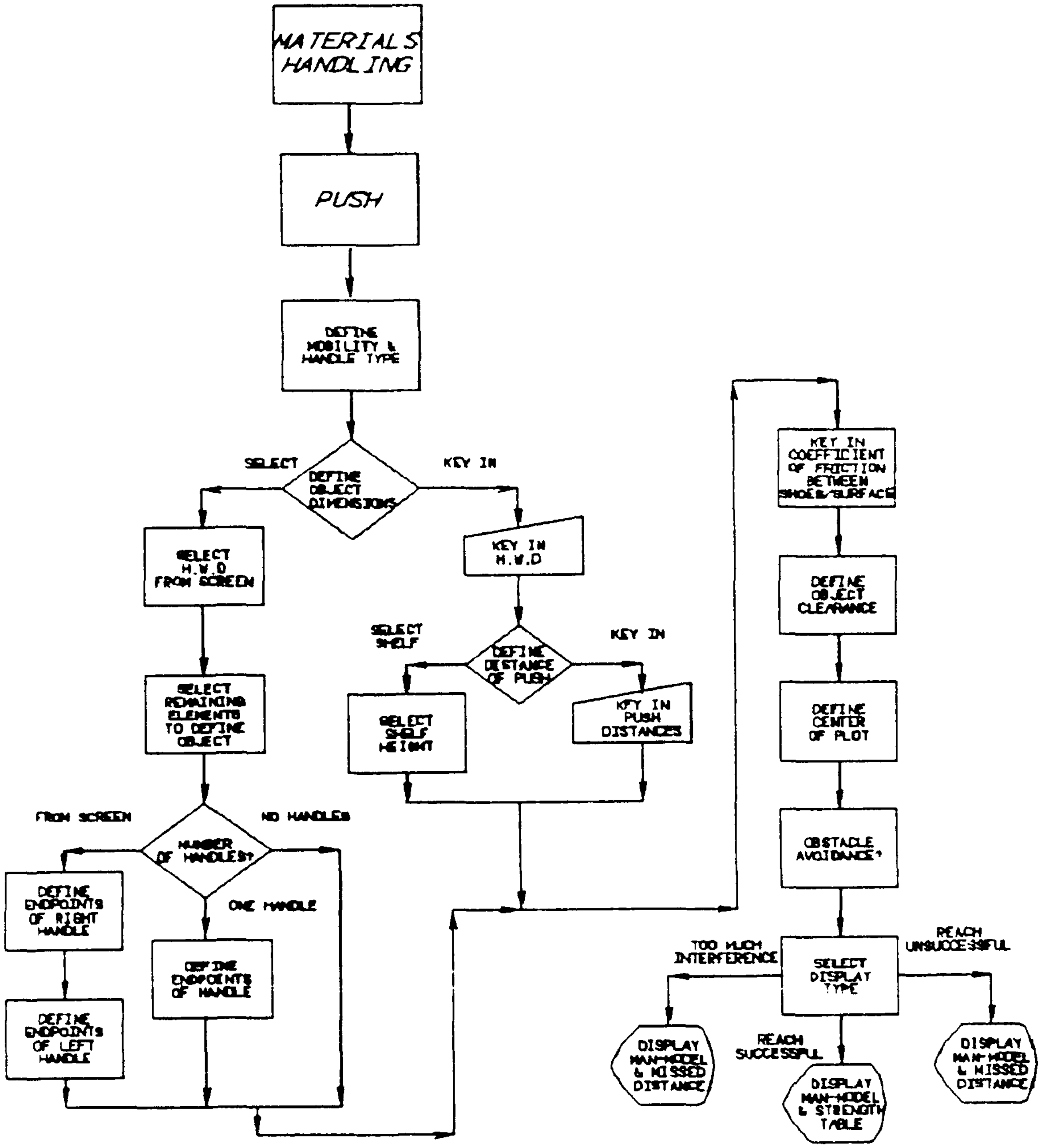


Figure 3.?3. Materials Handling Task Analysis Flow Diagram for PUSH Task.

3.2.5 PULL

PULL is the fifth of the six materials handling tasks and is selected when the man-model moves an object toward the man-model in a horizontal direction without supporting the weight of the object. The PULL task is always performed with BOTH HANDS. For this example, begin by selecting Materials Handling Task menu (see Figure 3.25) from the Task Analysis menu (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the name of the task to use for the analysis (see Figure 3.24).

EXAMPLE: Select the **PULL icon.**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

ACTION: Depress the **Y/N** function key to execute the Pull Task.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM PLLUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING THE TASK

ACTION: Select mobility type to be used during the reach analysis (see Figure 3.7).

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **FULL BODY.**

RESULT: New prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select handle type to be used in the analysis (Figure 3.34).

EXAMPLE: Select **ONE HANDLE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select whether you wish to key in values to define the object dimensions, or if you wish to select elements from the screen to define the object dimensions. If you choose to select elements from the screen only straight lines and two-point splines are recognized as valid elements.

- Choose **SELECT OBJECT FROM SCREEN** if the object dimensions are to be defined by selecting screen elements.

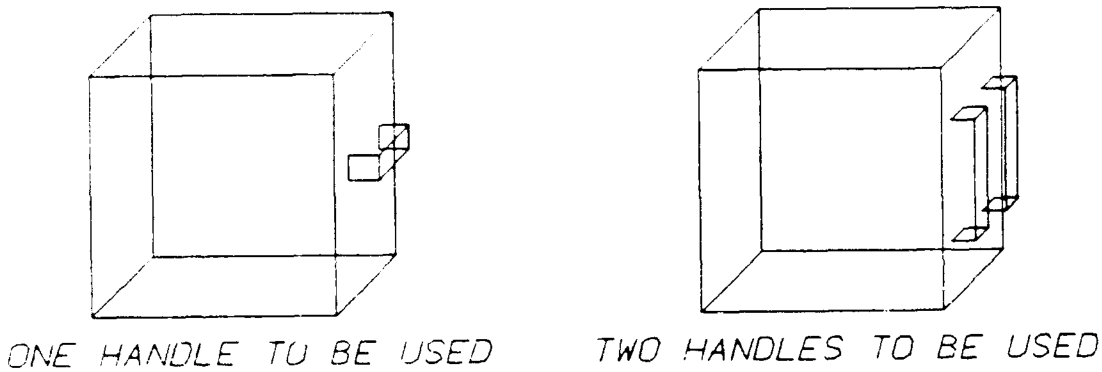


Figure 3.34. Handle Selection Menu (ONE HANDLE or TWO HANLLES).

OR:

- Select **KEY IN OBJECT DIMENSIONS** if the object dimensions are to be defined by keying in values.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS.**

RESULT: New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH. When these other elements have been defined, the user would select END from the bottom menu. These elements define an irregularly shaped object. (See Paragraph 8.2.2.3.) If the object dimensions are keyed-in, the handle(s) will automatically be placed on top of the object by the program. If the user selects **KEY IN OBJECT DIMENSIONS**, as in the example, the following prompt will appear on the screen.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in a value **<CR>** to define the height of the object.

EXAMPLE: Key in **10.3 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in a value **<CR>** to define the width of the object.

EXAMPLE: Key in **12.0 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in a value **<CR>** to define the depth of the object.

EXAMPLE: Key in **12.0 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR OBJECT

ACTION: Select whether you wish to key in values to define the shelf height and distance of pull, or if you wish to select an element from the screen to define these distances.

- Choose **SELECT LINE TO DEFINE OBJECT DISTANCES** if the pull distances are to be defined by selecting an element from the screen.

OR:

- Choose **KEY IN OBJECT DISTANCES** if the pull distances are to be defined by keying in values.

EXAMPLE: Select **KEY IN OBJECT DISTANCES**.

RESULT: New prompt appears.

PROMPT: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

ACTION: Key in a value <CR> to define the vertical distance for the pull.

EXAMPLE: Key in **45.0 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

ACTION: Key in a value <CR> to define the horizontal pull distance.

EXAMPLE: Key in **20.5 <CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN COEFFICIENT OF FRICTION

ACTION: Key in a value <CR> to define the coefficient of friction between the technician's shoes and the surface on which he is standing for this analysis. (See Figure 7.3 [HELP page] for Coefficient of Friction table.)

EXAMPLE: Key in **0.79 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MENU WHICH IDENTIFIES THE NEED FOR OBJECT CLEARANCE

ACTION: Select the type of object clearance desired in this analysis. Object clearance is the space

between the object and the inner surfaces of the containing area.

- Choose **CLEARANCE IS CRITICAL** if the object will has a tight clearance.

OR:

- Choose **CLEARANCE NOT CRITICAL** if the object will easily clear the area into which it will be placed.

EXAMPLE: Select **CLEARANCE IS CRITICAL.**

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point on the screen to approximately position the center of the strength table upon completion of a successful reach.

RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during reach analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **DO NOT PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME.**

RESULT: If the man-model is able to pull the object successfully, the man-model appears superimposed in the drawing as a wire-frame model pulling the object with his hands either on the object or on the handles. A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is

unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.35 diagrams the flow of actions necessary to execute a PULL analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2.6 REACH

REACH is the last of the materials handling tasks, and is selected when the man-model moves empty hands to a different location. For this example, begin by selecting Materials Handling Task menu (see Figure 3.25) from the Task Analysis Menu (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

ACTION: Depress the **Y/N** function key to execute the Reach Task.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM REAUSR EXECUTING appears and then a new prompt and menu appear.

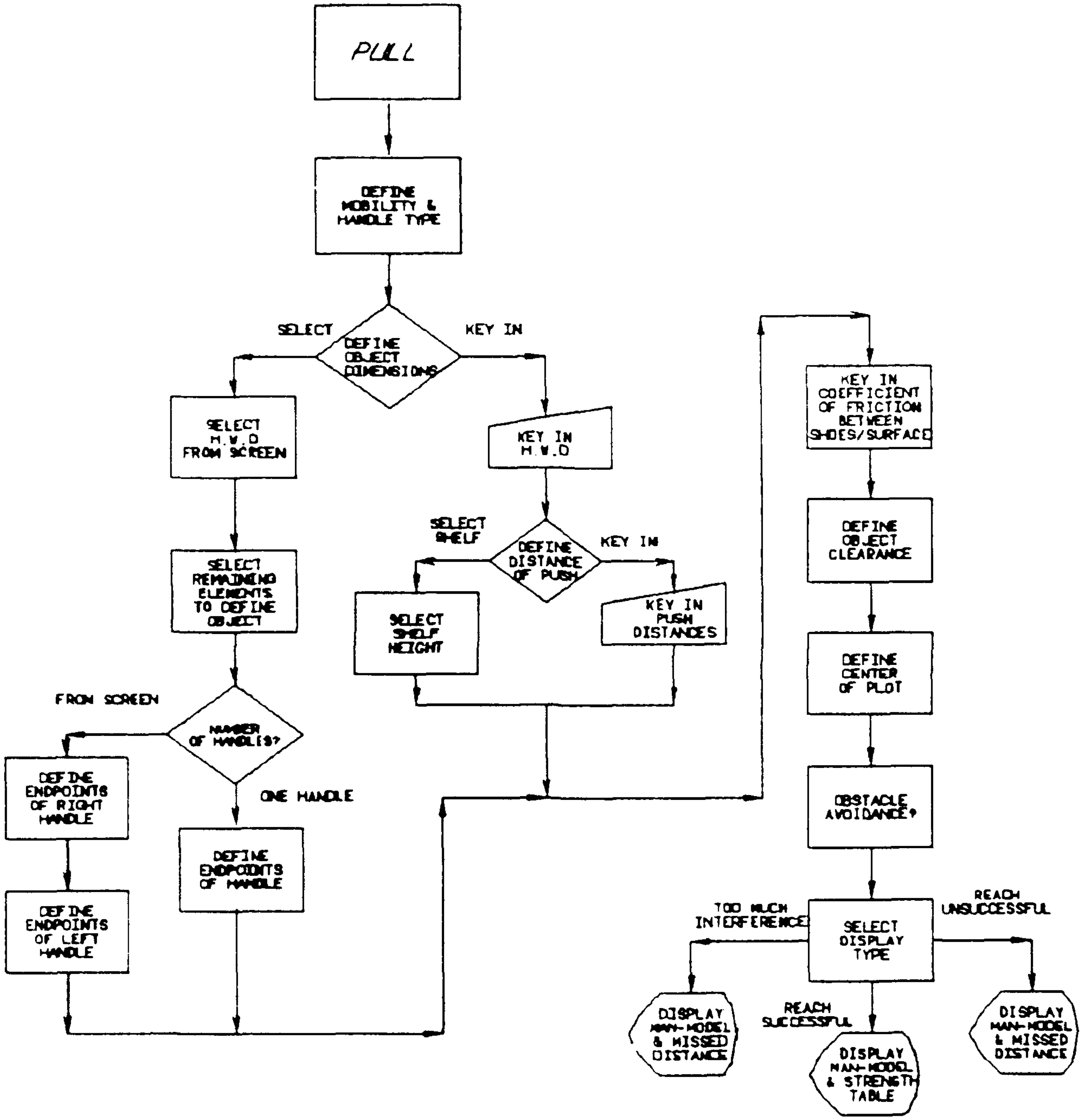


Figure 3.35. Materials Handling Analysis Flow Diagram for PULL Task.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the name of the task to use for the analysis (see Figure 3.25).

EXAMPLE: Select the **REACH icon.**

RESULT: New prompt appears.

PROMPT: SELECT ARM TO BE USED DURING TASK

ACTION: Select which arm will be used in the reach analysis (Figure 3.36).

EXAMPLE: Select **LEFT ARM.**

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select mobility type to use in the reach analysis (see Figure 3.7).

- Choose **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

<u>OR:</u>

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

<u>OR:</u>

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

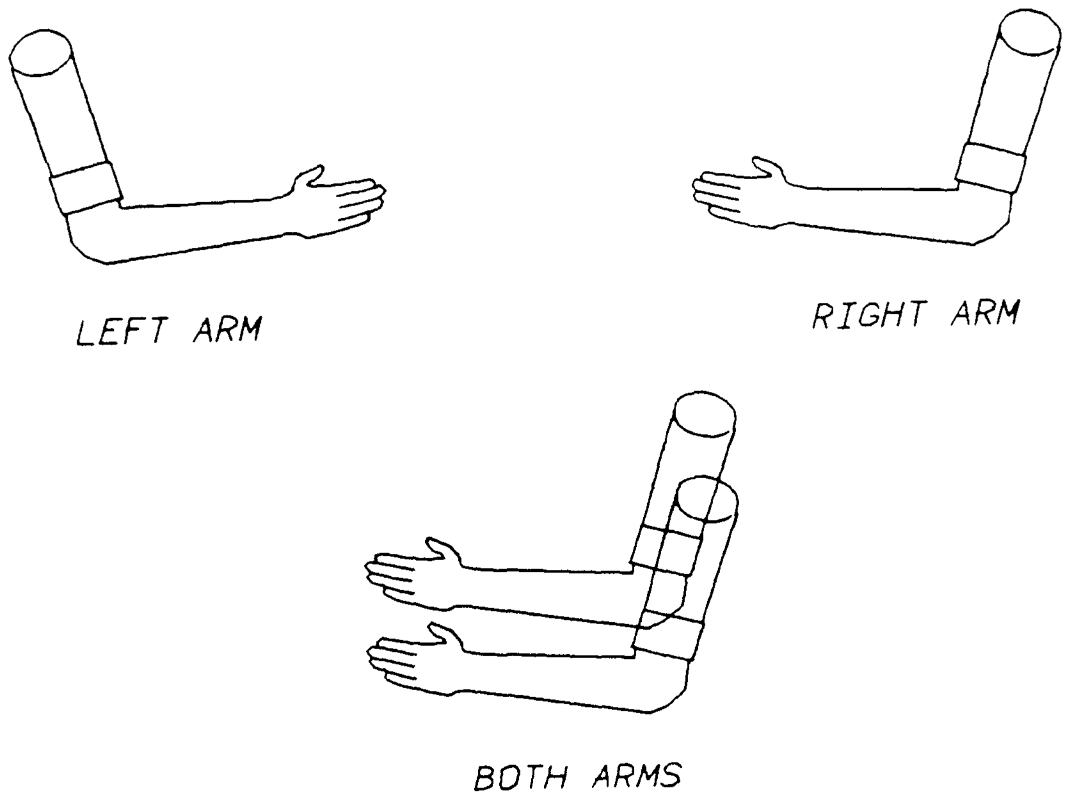


Figure 3.36. Arm Selection Menu (RIGHT ARM, LEFT ARM, and BOTH ARMS).

EXAMPLE: Select **FULL BODY.**

RESULT: New prompt and menu appear.

PROMPT: SELECT REACH EXTENT TO BE USED DURING THE TASK

ACTION: Select the reach grip type to be used in the analysis (Figure 3.37).

EXAMPLE: Select **FUNCTIONAL.**

RESULT: New prompt and menu appear.

PROMPT: SELECT REACH POINT FOR LEFT ARM

ACTION: Define a 3-D point toward which the man-model will reach.

- Select an existing 3-D point from the screen to determine the reach point.

OR:

- Key in the X,Y,Z coordinates **<CR>** to determine the reach point.

EXAMPLE: Key in **26.74, 170, 39.98 <CR>.**

RESULT: New prompt appears.

If RIGHT (arm) had been selected the prompts would have similar. If BOTH (arms) had been selected, the prompt for the right hand reach point would have appeared, followed by a prompt for the left hand reach point. (See Paragraph 8.2.2.6.)

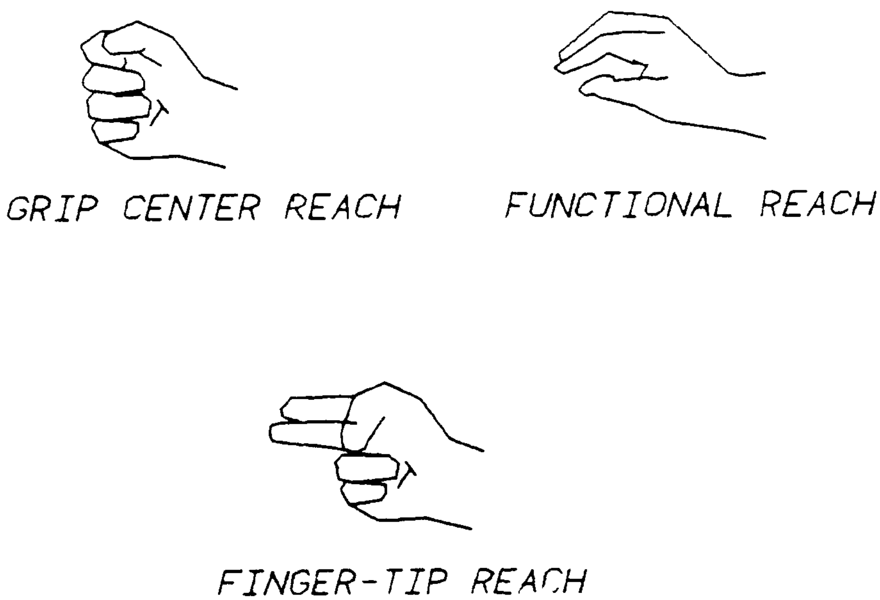


Figure 3.37. Grip Type Selection Menu for REACH Task.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during reach analysis; execution time is increased.

<u>OR:</u>

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit include obstacle avoidance.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

<u>OR:</u>

- Select **SURFACED** to display a meshed man-model to be used in shading.

<u>**OR:**</u>

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point successfully, the man-model appears superimposed in the drawing as a wire-frame model in the final reach position. A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the reach point is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.38 diagrams the flow of actions necessary to execute a REACH task.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.3 CONNECTOR ANALYSIS FUNCTION

The Connector Analysis function evaluates the strength capability of the technician to mate an electrical connector at a specified location. This evaluation is given in a table of strength capability related to grip used and size of connector.

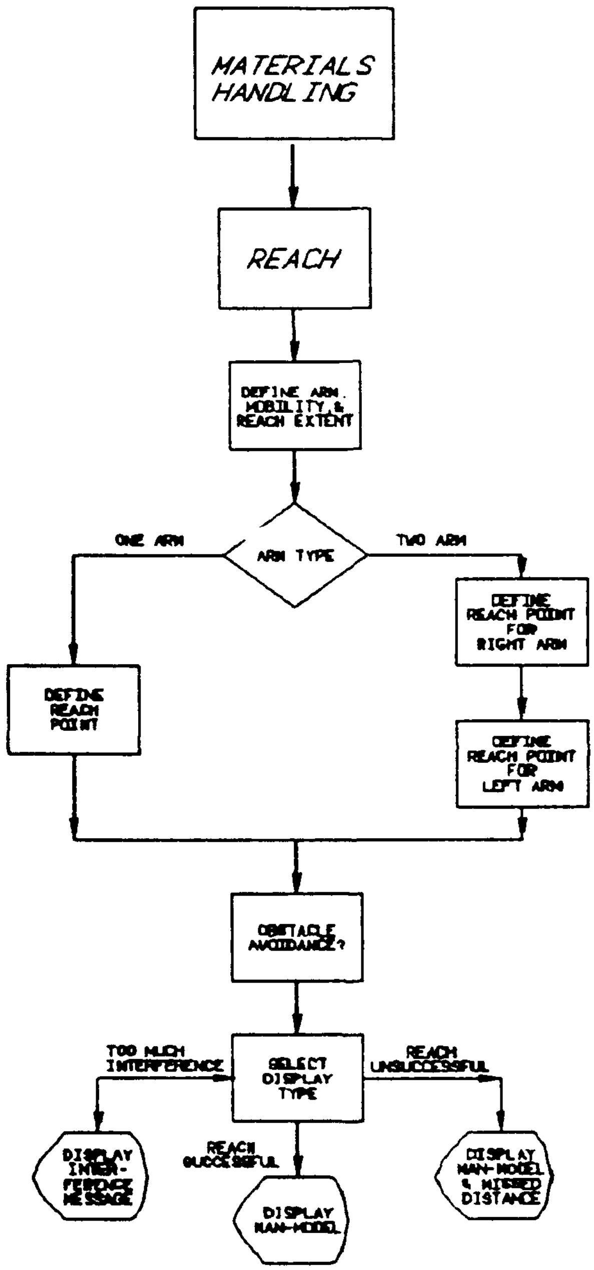


Figure 3.38. Materials Handling Analysis Flow Diagram for REACH Task.

To use the Connector Analysis function, choose the TASK ANALYSIS from the CREW CHIEF Main Programs menu (see Figure 1.3) which will cause the CREW CHIEF Task Analysis menu to appear on the screen (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

ACTION: Select the Task Analysis function to be performed (see Figure 3.1).

EXAMPLE: Select the **CONNECTOR icon.**

RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TO BE USED DURING TASK

ACTION: Select the grip type (Figure 3.39).

EXAMPLE: Select **GRIP CENTER.**

RESULT: New prompt and menu appear.

PROMPT: SELECT CONNECTOR SIZE TO BE USED DURING TASK

ACTION: Select the connector size (diameter of lock ring) to be used in the analysis (Figure 3.40).

EXAMPLE: Select **2.0 INCHES.**

RESULT: New prompt and menu appear.

Figure 3.39. Grip Type Selection Menu for Connector.

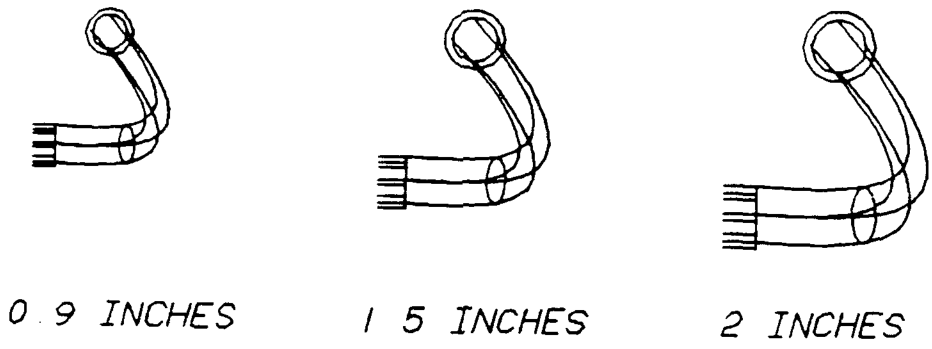


Figure 3.40. Connector Size Menu.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Define a 3-D point that defines at which point the man-model grips the connector.

- Select an existing 3-D point from the screen to determine where the man-model will grip the connector.

<u>OR:</u>

- Key in the X,Y,Z coordinates which represent where the man-model will grip the connector **<CR>**.

EXAMPLE: Key in **28, 218, 44.75 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define a 3-D point that (along with the head point, or the point at which the man-model grips the connector) defines the direction from which the man-model will reach the connector.

- Select an existing 3-D point from the screen to define the axis of the connector and the direction the man-model will reach.

<u>OR:</u>

- Key in the X,Y,Z coordinates which will define the axis of the connector and the direction the man-model will reach **<CR>**.

EXAMPLE: Key in **28, 221, 44.75 <CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

ACTION: Select which arm will reach to the connector (see Figure 3.17).

EXAMPLE: Select **LEFT HAND.**

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used in the reach analysis (see Figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

OR:

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY.**

RESULT: New prompt appears.

PROMPT: INDICATE CENTER OF PLOT

ACTION: Indicate a point on the window to approximately position the center of the strength-related measurements upon completion of a successful reach.

RESULT: New prompt and new bottom menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during reach analysis; execution time is increased.

<u>OR:</u>

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the connector, the man-model appears superimposed in the drawing as a wire-frame model holding the connector. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. A table of strength-related measurements is displayed. If the reach is unsuccessful because the distance between the man-model and the connector is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.41 diagrams the flow of actions necessary to execute the connector analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is

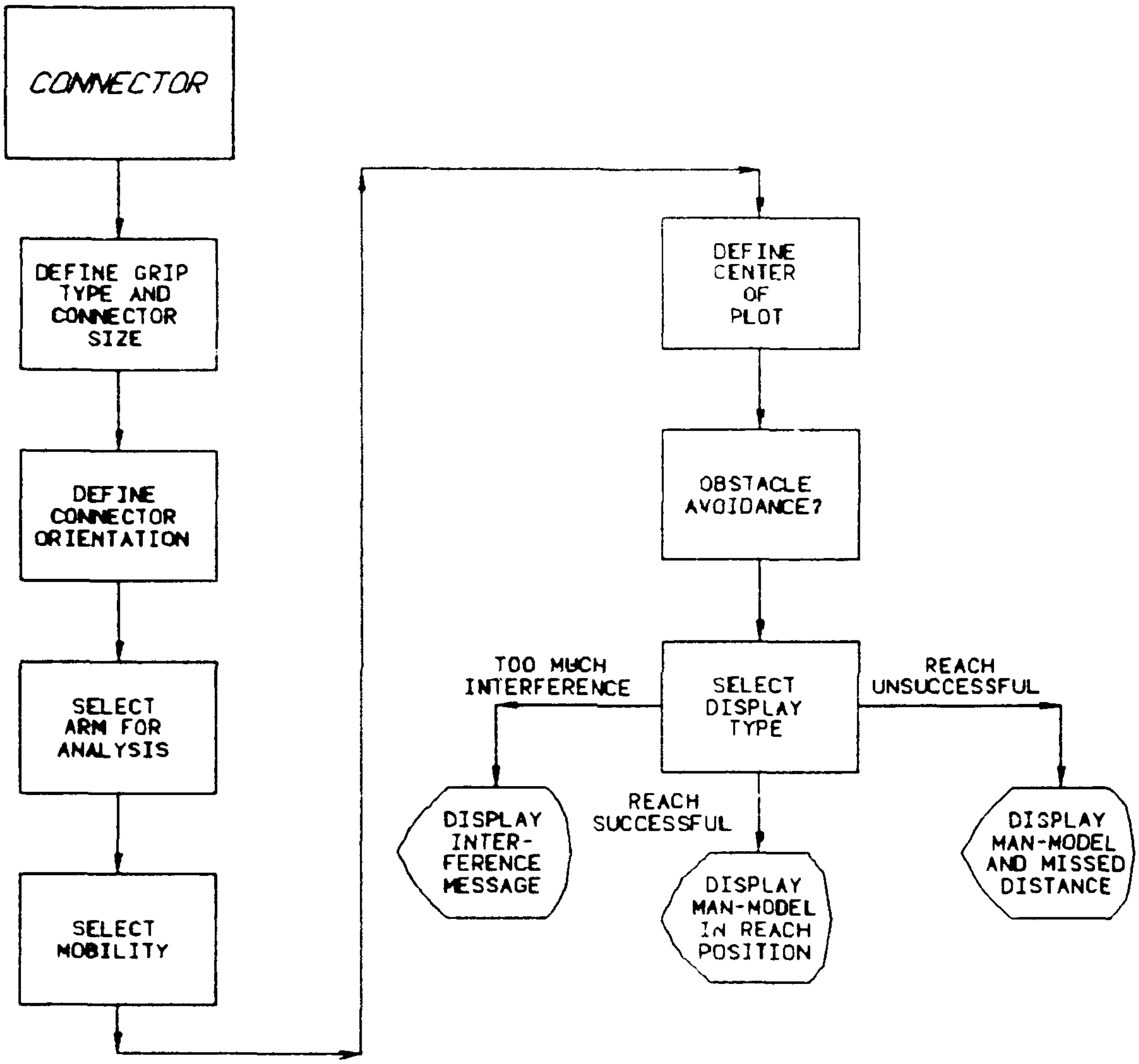


Figure 3.41. Materials Handling Task Analyses Flow Diagram for Connector.

also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

SECTION 4
VISIBILITY ANALYSIS FUNCTION

4.1 INTRODUCTION TO VISIBILITY ANALYSIS

The Visibility Analysis Function program plots a map of visual azimuth and elevation line-of-sight (LOS) angles to work station components in the drawing. The plot is rectilinear, and depicts the visual field as seen by the CREW CHIEF man-model in its current posture, or as seen from a user-chosen, arbitrary viewpoint. The plot is presented on-screen and a hard copy can be obtained using the CADAM Plot Function.

The vision limits will be presented for the baseline condition, which is unrestricted, and for restrictions due to clothing or personal protective equipment such as the Chemical Defense mask. These restrictions will be available as overlays in the program.

4.2 USING THE VISIBILITY ANALYSIS FUNCTION

The first step in using the Visibility Analysis function is to call the CREW CHIEF Main Programs menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **VISIBILITY icon**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Visibility Analysis Function

EXAMPLE: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM VISUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT VIEWPOINT OPTION

ACTION: Select the viewpoint that depicts the visual field as seen by the man-model or as seen from a user-defined, arbitrary viewpoint.

- Select **CREW CHIEF'S** to view the visual field as seen by the man-model from his current position and posture

OR:

- Select **USER DEFINED** to establish an arbitrary line-of-sight

EXAMPLE: Select **CREWCHIEF'S**

RESULT: New prompt appears.

If USER-DEFINED had been selected as the EXAMPLE, then the user would be prompted to DEFINE EYE LOCATION POINT from which the man-model will view the work location and to DEFINE EYE TARGET POINT which defines the man-model's line-of-sight. Next the user would be prompted to DEFINE CENTER OF PLOT for the visibility plot. (See Paragraph 8.3.) The following prompt appears as a result of selecting **CREW CHIEF'S**.

PROMPT: SELECT INCLUDE/EXCLUDE MAN-MODEL OPTION

ACTION: Select from the menu whether to include or exclude the man-model. Body parts of the man-model which are within the visual field of the man-model will or will not be included in the final visibility plot depending on this selection.

- Select **INCLUDE MAN** to include the body parts of the man-model which are within the visual field of the man-model in the final visibility plot

OR:

- Select **EXCLUDE MAN** to not include the body parts of the man-model which are within the visual field of the man-model in the final visibility plot

EXAMPLE: Select **INCLUDE MAN**

RESULT: New prompt appears.

PROMPT: DEFINE CENTER OF PLOT

ACTION: Indicate a 2-D point to determine where the center of the visibility plot will appear on the screen

EXAMPLE: Indicate a point on the screen

RESULT: Plot appears on screen at specified center of plot location. New menu appears.

Figures 4.1 through 4.3 are examples of vision outlines; the vision outline which appears is dependent upon the clothing type selected during CREW CHIEF Initialization. The bareheaded

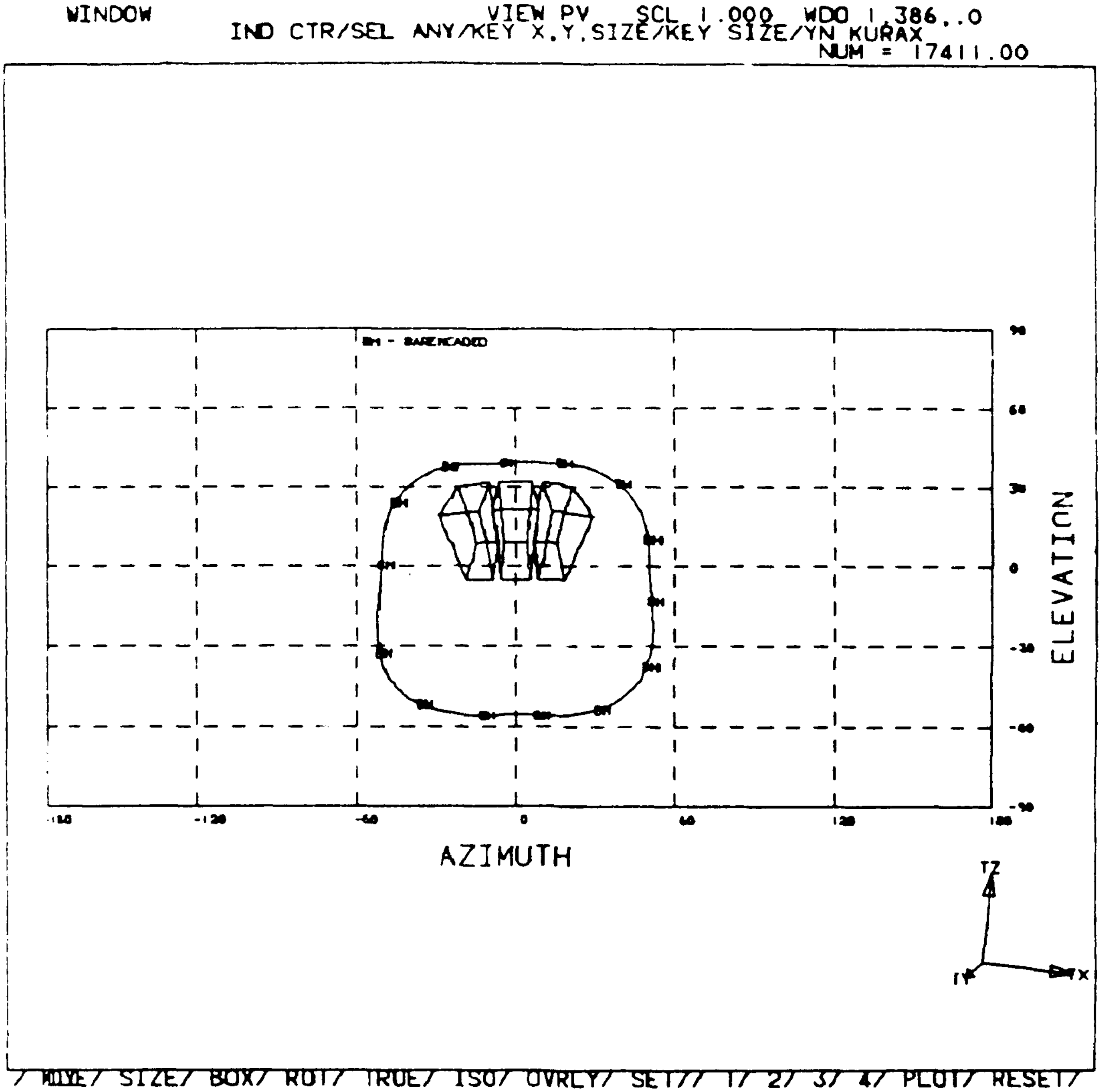


Figure 4.1. An Example of the Vision Outline Which is Shown When the Fatigues or the Fatigues with Jacket Clothing Type is Selected. "BH" Represents the Bareheaded Visual Field.

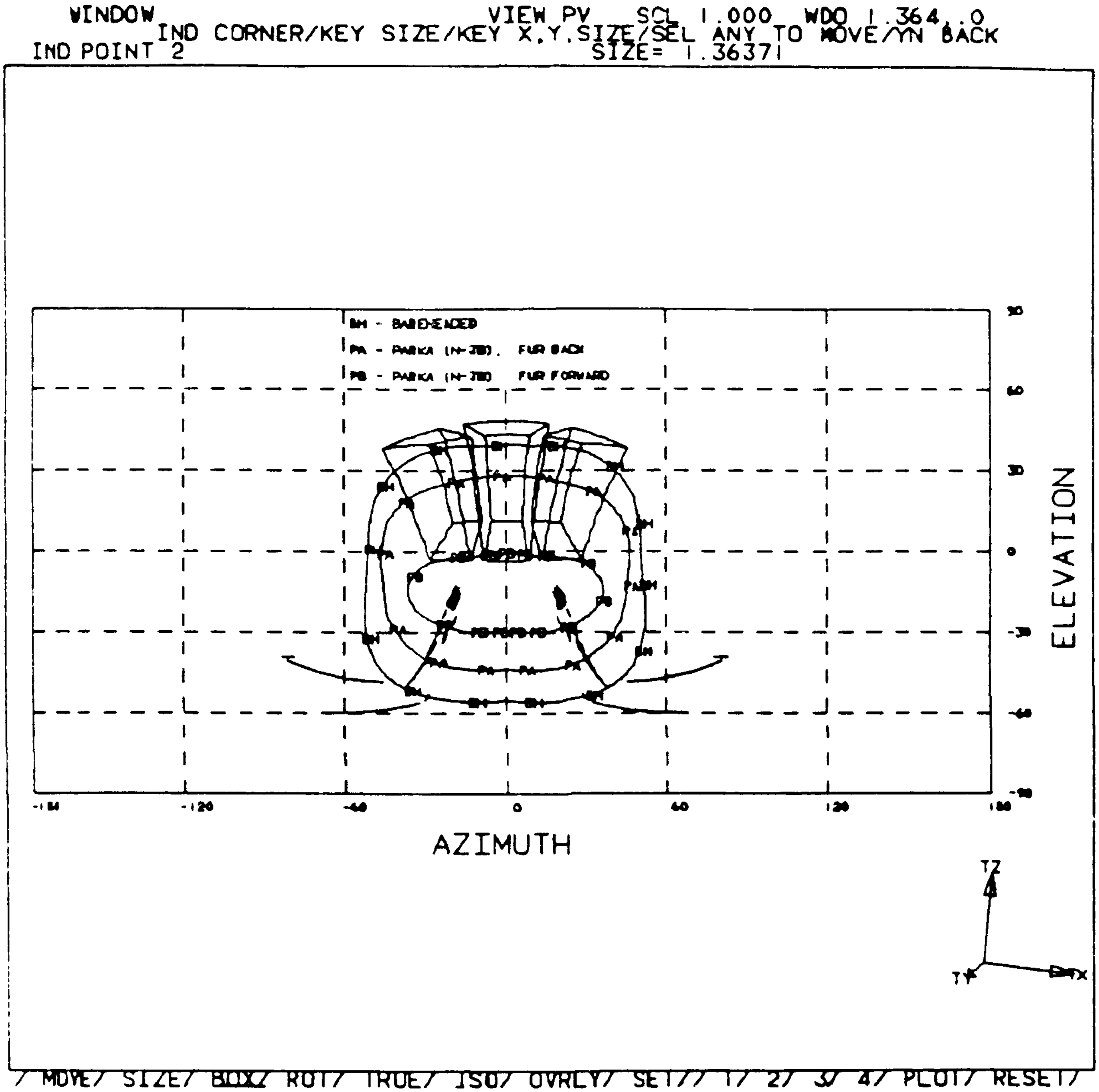


Figure 4.2. An Example of the Vision Outline Which is Shown When the Arctic Clothing Type is Selected. "PA" Represents the Visual Field with Fur-Trimmed Edge of the Parka Hood Pulled Away from the Face; "PB" Indicates the Visual Field with Fur Edge of Hood Pushed Toward the Face. "BH" Shows the Bareheaded Visual Field.

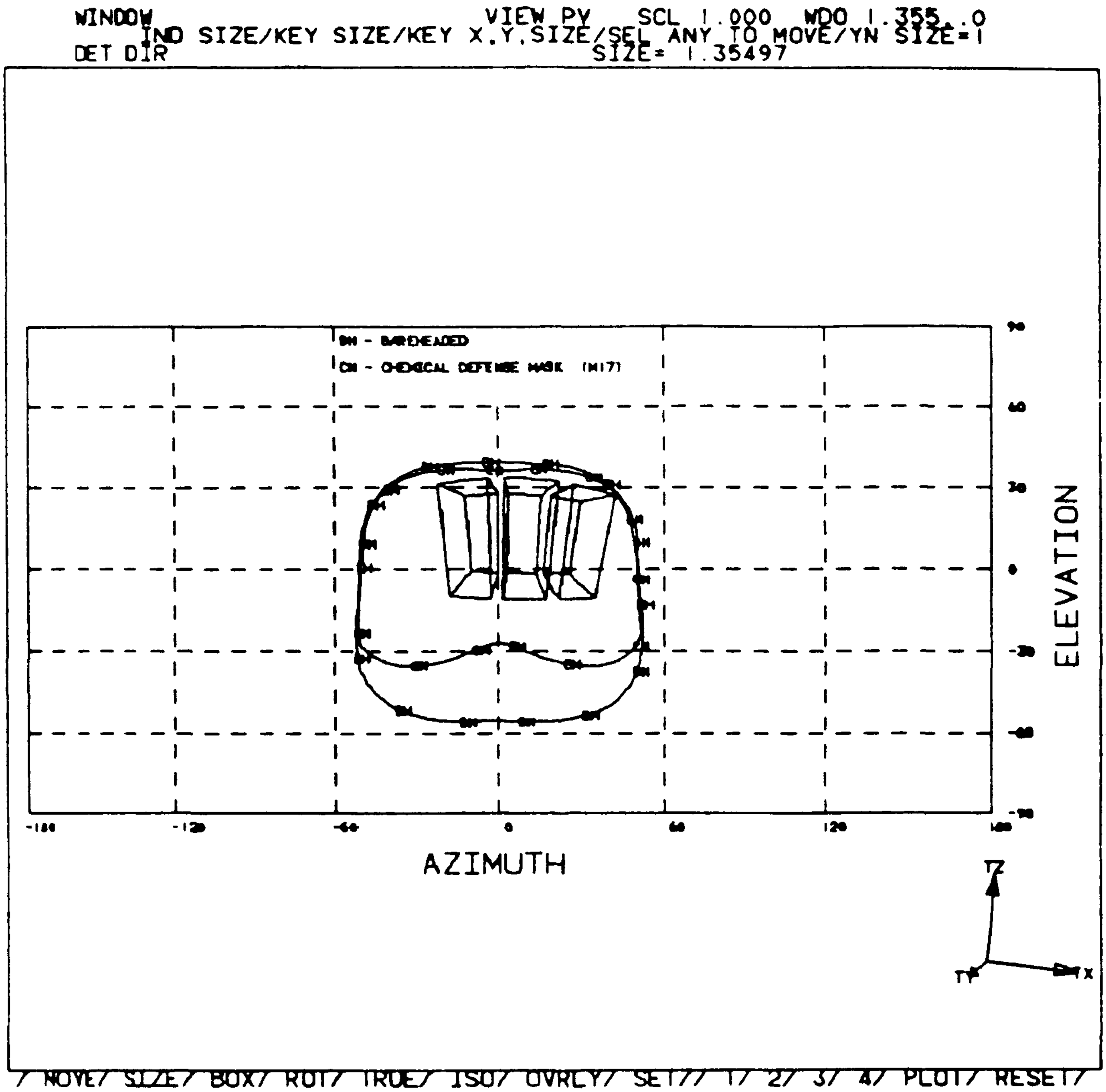


Figure 4.3. An Example of the Vision Outline Which is Shown When the Chemical Defense Clothing Type is Selected. "CM" Represents the Visual Field with Chemical Defense Mask. "BH" Shows the Bareheaded Visual Field.

vision outline, shown by a solid contour and the letters "BH" (see Figure 4.1, i.e., the result of choosing fatigues or fatigues with jacket), is plotted regardless of the clothing type selected.

When the arctic ensemble is selected, two dashed contours appear (see Figure 4.2). The outline labeled "PA" represents the visual field of the man-model wearing the parka hood with the fur-trimmed edge pulled away from the face. The outline labeled "PB" denotes the visual field with the parka hood fur edge pushed toward the face (in the snorkel opening position). The bareheaded vision outline, as described previously, is also displayed.

If the chemical defense ensemble is selected, the dashed contour labeled "CM" appears (see Figure 4.3). Again, the bareheaded vision outline described previously is also displayed.

After the plot appears on the screen, it may be necessary to increase the size of the plot to be viewed correctly. This can be accomplished by depressing CADAM's window function key and using the appropriate menu items to view the plot. After the user has viewed the plot, he/she should depress the Macro Geometry function key to continue any analysis.

Figure 4.4 diagrams the flow of action necessary to execute a visibility analysis.

To continue the analysis, the user will generally select **/RECOVER/** from bottom of screen to return to CREW CHIEF Main Programs menu. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

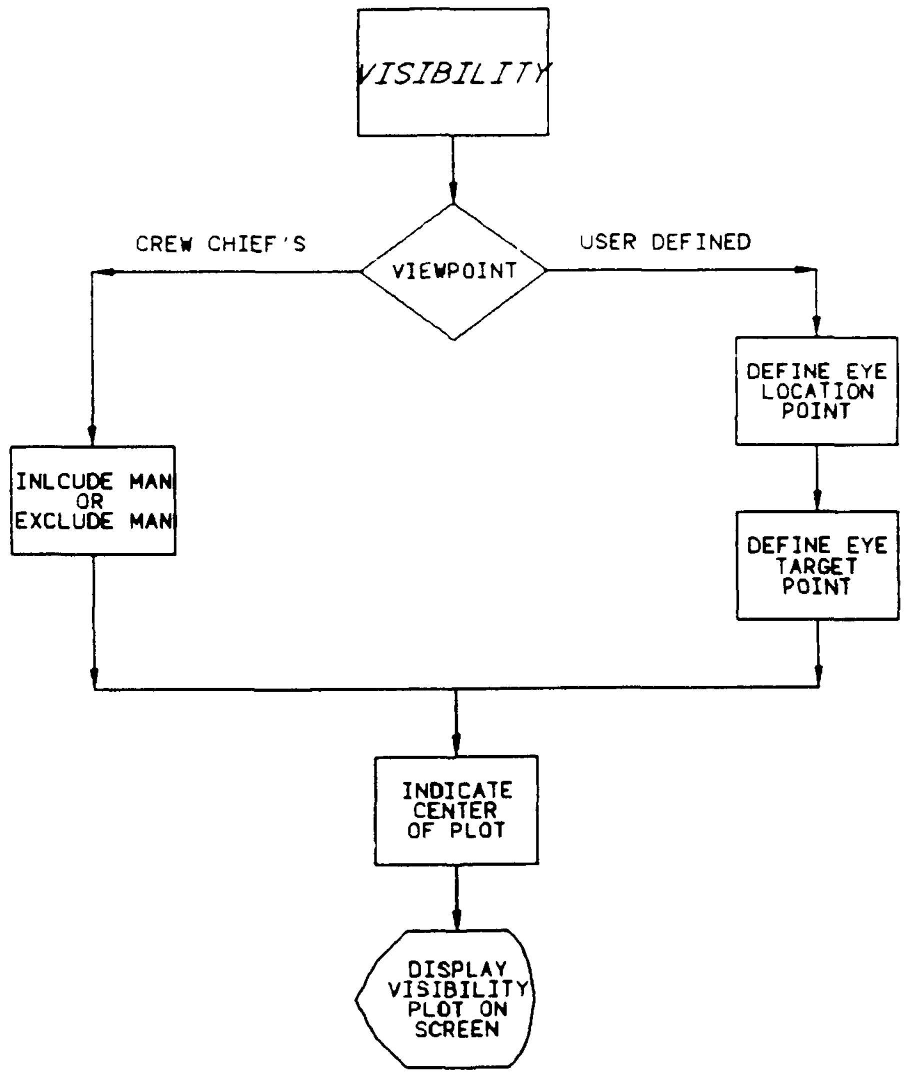


Figure 4.4. Visibility Analysis Flow Diagram.

SECTION 5

ACCESSIBILITY ANALYSES FUNCTION

The Accessibility Analyses function is provided to perform analyses concerning interference between elements of the CREW CHIEF technician model and elements of the drawing depicting the location of work. The function is broken into two areas: Interference Analysis, which checks interference between the man-model and drawing elements in a static condition, and Work Envelope Analysis, which is a quasi-dynamic interference check. Work Envelope presents a graphic display of the volume of space required to operate a tool or the movement of an object, such as a component to be removed or installed, in the work area.

Interference can be observed on the screen by viewing both the drawing and the man-model from different perspectives. In some cases this is the easiest and quickest way for the user to check for interference.

The Accessibility Analysis function is initiated from the CREW CHIEF Main Program Menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the analysis to be performed

EXAMPLE: Select the **ACCESSIBILITY icon** (Figure 5.1).

Choose the desired Accessibility Analysis function by selecting the **INTERFERENCE** or **WORK ENVELOPE** icon.

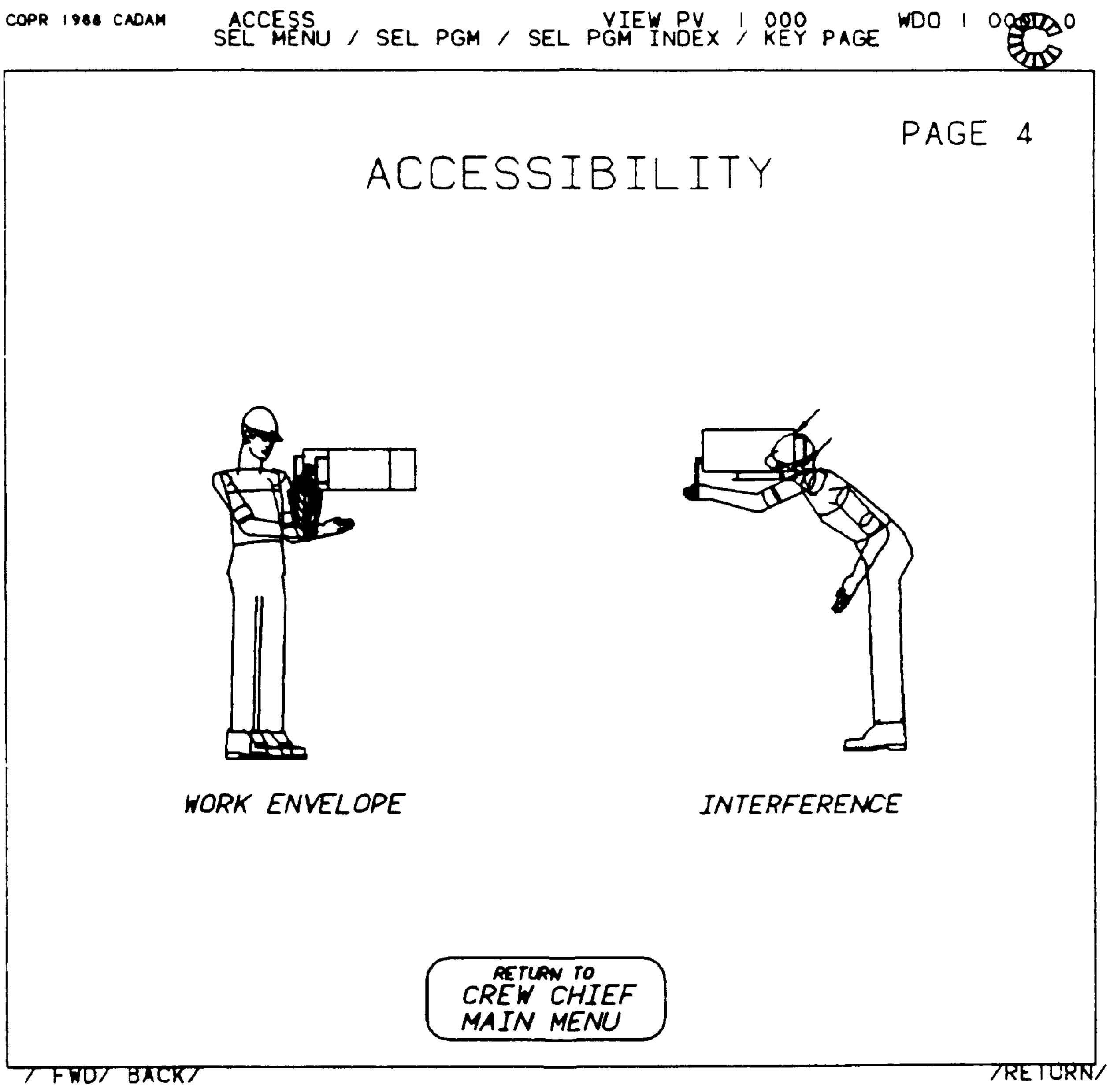


Figure 5.1. CREW CHIEF Accessibility Analyses Menu.

5.1 CREW CHIEF INTERFERENCE ANALYSIS FUNCTION

5.1.1 Introduction to Interference Analysis

Interference checking of a complex drawing is generally a time-consuming process. For this reason, the user should employ the "NO-SHOW" capabilities of CADAM to temporarily remove drawing elements that are obviously out of the interference range of the man-model elements.

The CREW CHIEF program also allows the user to check inter- ference for the whole body or portions of the body (with or without a tool). The user can check interference for the shoulders, arms and hand, or the upper torso which includes all body elements from the waist up, or the whole body. A tool will be included if a tool was used in the previous analysis. By using the "NO-SHOW" capabilities of CADAM, the program only has to check the "shown" drawing elements and the designated body/tool elements for interference, a task which significantly reduces computer processing time.

Interference checking is performed using the current posture configuration and position of the man-model. Thus, before performing any Interference Analysis, the man-model must be generated and placed in the desired posture and position using the Initialization, Reposition, and/or Task Analysis functions. The program searches for interference between the man-model and drawing elements, displays CADAM 3-D arrows indicating points of interference, and indicates at the top of the screen whether or not interference is found.

5.1.2 Using the Interference Analysis Function

To use the Interference Analysis function, select ACCESSIBILITY icon from the CREW CHIEF Main Programs menu (see Figure 1.3) which will display the CREW CHIEF Accessibility Analysis menu (see Figure 5.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **INTERFERENCE icon**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Interference Analysis Function.

EXAMPLE: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM ITFUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT LEVEL OF INTERFERENCE TO BE CHECKED

ACTION: Select the level of interference checking to be used (Figure 5.2). The level of interference checking chosen determines which body parts will be included during interference checking. The more body parts contained in the level, the more execution time is required to evaluate the interference. Also execution time of the interference analysis will decrease if elements that definitely do not interfere with the man-model are "NO-SHOWED" before the analysis.

- Select **ARMS ONLY** to include only the arms, hands, and tool (if applicable) for possible interference between the man-model and the elements in the drawing

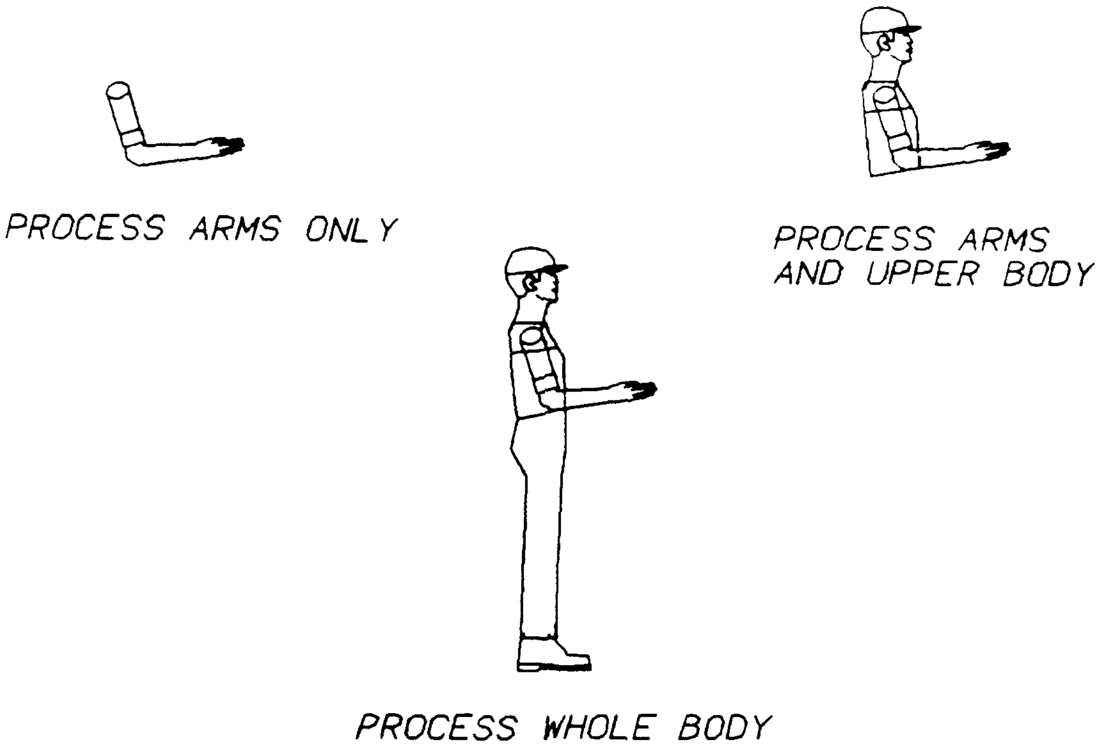


Figure 5.2. Level of Interference Checking Menu.

OR:

- Select **ARMS AND UPPER TORSO** to include all body elements from the waist up for possible interference between the man-model and the elements in the drawing

OR:

- Select **FULL BODY** to include the whole body for possible interference between the man-model and the elements in the drawing

EXAMPLE: Select **ARMS AND UPPER TORSO**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE)

- Select **WIREFRAME** to display a 3-D wire-frame man-model

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading

OR:

- Select **PROFILE** to display profile view of man-model

EXAMPLE: Select **WIREFRAME**

RESULT: The man-model will appear in the drawing as a wire-frame model. If interference was found, 3-D arrows indicate the points where the man-model (depending on level of interference chosen) inter sects with elements in the drawing. The message "ARROWS BELOW INDICATE POINT OF INTERFERENCE" is displayed. If no interference is found, then the message "NO INTERFERENCE FOUND IN UPPER BODY LEVEL" is displayed (this message will change depending on level of interference selected).

Figure 5.3 diagrams the flow of actions necessary to execute an Interference Analysis.

To continue the analysis, the user will generally select **/RECOVER/** from bottom of screen. Another selection is available to the user. If /KEEP/ is selected, OVERLAY becomes the active drawing.

5.2 WORK ENVELOPE ANALYSIS FUNCTION

Prior to using the Work Envelope Analysis function, the user will be required to perform a Task Analysis to establish the parameters for the volume required for using a tool or handling an object.

5.2.1 Introduction to Work Envelope Analysis

The work envelope analysis currently evaluates the volume of space that is available for the operation of a tool task. The function requires that a successful obstacle avoidance tool reach was previously performed. The work envelope is defined relative to the location of the tool as defined in the Tool Analysis function (see Paragraph 3.1), and can be greatly affected by the handle direction chosen.

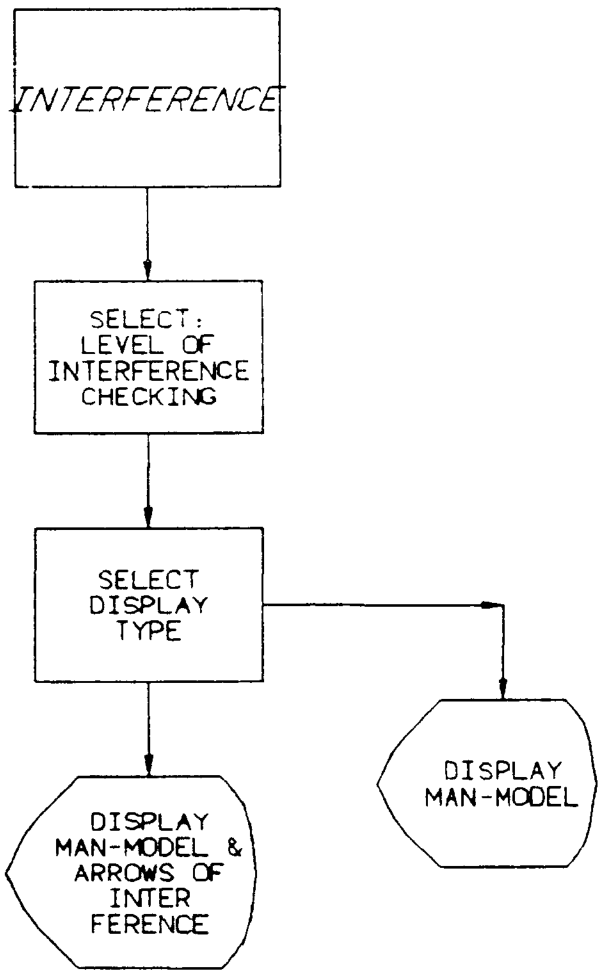


Figure 5.3. Interference Analysis Flow Diagram.

The Work Envelope evaluates three types of envelopes. In the first type of envelope, a full sweep of the tool handle can be viewed. This evaluation does not take into account obstructions in the work place or the ability of the man-model to reach the tool handle for the full sweep. In the second type of envelope, a tool envelope can be evaluated. This considers obstructions that will affect the sweep of the tool, but reach is not evaluated. The third type of envelope is the work envelope. This evaluates the ability of the man-model to reach the handle of the tool during the sweep of the tool, and also takes into account obstacles in the work place. The work envelope can be very time-consuming, depending upon the reach interval increment given and the number of obstacles near the tool.

Several tools available in the Tool Analysis function have undefined envelopes: hammer, scraper, and safety wire pliers. Also several tools do not have an envelope: drill, chisel, sander, combination pliers, needlenose pliers, wire cutters, nutdriver, flat bladed screwdrivers, and when using long end allen wrenches.

5.2.2 Using the Work Envelope Analysis Function

To use the Work Envelope Analysis function, select the ACCESSIBILITY icon from the CREW CHIEF Main Programs menu (see Figure 1.3) which will display the CREW CHIEF Accessibility Analysis menu (see Figure 5.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **WORK ENVELOPE icon**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the Y/N function key to execute the Work Envelope Analysis Function.

EXAMPLE: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM WRKUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT WORK ENVELOPE TO BE OUTPUT

ACTION: Select one of the envelope types to be evaluated (Figure 5.4). The envelope type chosen will affect the execution time of the analysis. The sweep volume will require the least amount of time since reach and obstacles are not considered. The work envelope will require the greatest amount of time, because it considers the number of obstacles near the tool and the ability to reach the tool handle during the sweep of the tool.

- Select **SWEPT VOLUME** to evaluate the sweep of the tool handle (ability to reach the tool handle and obstacles in the reach path are not considered)

<u>OR:</u>

- Select **TOOL ENVELOPE**, to evaluate the sweep of the tool handle considering obstacles in the sweep path [tool handle position will effect this envelope (Figure 5.5)]

<u>OR:</u>

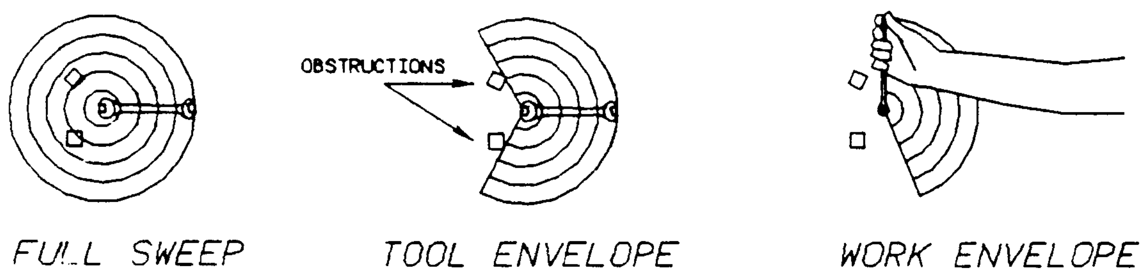


Figure 5.4. Types of Work Envelopes Menu.

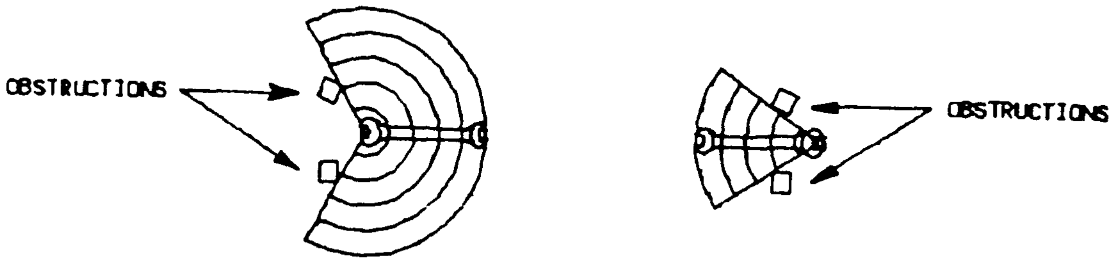


Figure 5.5. The Work Envelope, Defined Relative to the Location of the Tool, is Greatly Affected by the Chosen Handle Direction. To Change Handle Direction, User Must Rerun the Tool Analysis.

- Select **WORK ENVELOPE** to evaluate the sweep of the tool handle considering the ability of the man-model to reach the handle and any obstacles that are in the sweep path [tool handle position will effect this envelope (see Figure 5.5)]

EXAMPLE: Select **WORK ENVELOPE**

RESULT: New prompt and menu appear.

If the example chosen had been either SWEPT VOLUME or TOOL ENVELOPE, the user would next select a DISPLAY TYPE and the final results of the analysis would appear on the screen. As a result of selecting **WORK ENVELOPE**, the following prompt must be considered.

PROMPT: KEY IN WORK ENVELOPE REACH INCREMENT, MUST BE >0

ACTION: Determine the reach increment to be used by keying the value <CR>. The reach increment is the increment used for the sweep of the tool handle. The ability of the man-model to reach the handle at each of these increments (along with obstacles) is evaluated.

<u>NOTE:</u> The reach increment must be equal to or greater than 0.5 inches.

EXAMPLE: Key in **1.5 <CR>**

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used in the reach analysis

- Select **ARM/SHOULDER** to allow movement of arms and shoulders only

OR:

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility

OR:

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility

EXAMPLE: Select **UPPER BODY**
RESULT: A new prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE)

- Select **WIREFRAME** to display a 3-D wire-frame man-model

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading man-model

OR:

- Select **PROFILE** to display profile view of man-model

EXAMPLE: Select **WIREFRAME**

RESULT: If the envelope type chosen was WORK ENVELOPE, the man-model appears in the drawing with the tool(s) attached as it was in the previous tool analysis. The sweep demarcation lines, which are dependent upon the ability of the man-model to reach the tool(s) during the handle sweep and the obstacles that would possibly prevent a full sweep of the tool, appear. If the envelope type chosen was either SWEPT VOLUME or TOOL ENVELOPE, only the sweep demarcation lines and the tool(s) appear. For SWEPT VOLUME, these lines indicate a full sweep of the tool handle without any restrictions. For TOOL ENVELOPE, these lines indicate the handle sweep possible if obstacles are considered (see Figure 7.8).

NOTE: If the display of the envelope is from a rotational type tool (e.g., wrenches), then the lines displayed represent the clockwise and counterclockwise angle (in degrees) with relation to the initial tool position. The direction of clockwise angles is in the same direction of a right-threaded screw or bolt. Likewise, counterclockwise is in the opposite direction. If the enveloped displayed represents a translation type tool (hacksaw, file, etc.), then the lines represent the distance that the tool can travel in a forward direction (in user-defined units).

Figure 5.6 diagrams the flow of actions necessary to execute a Work Envelope Analysis.

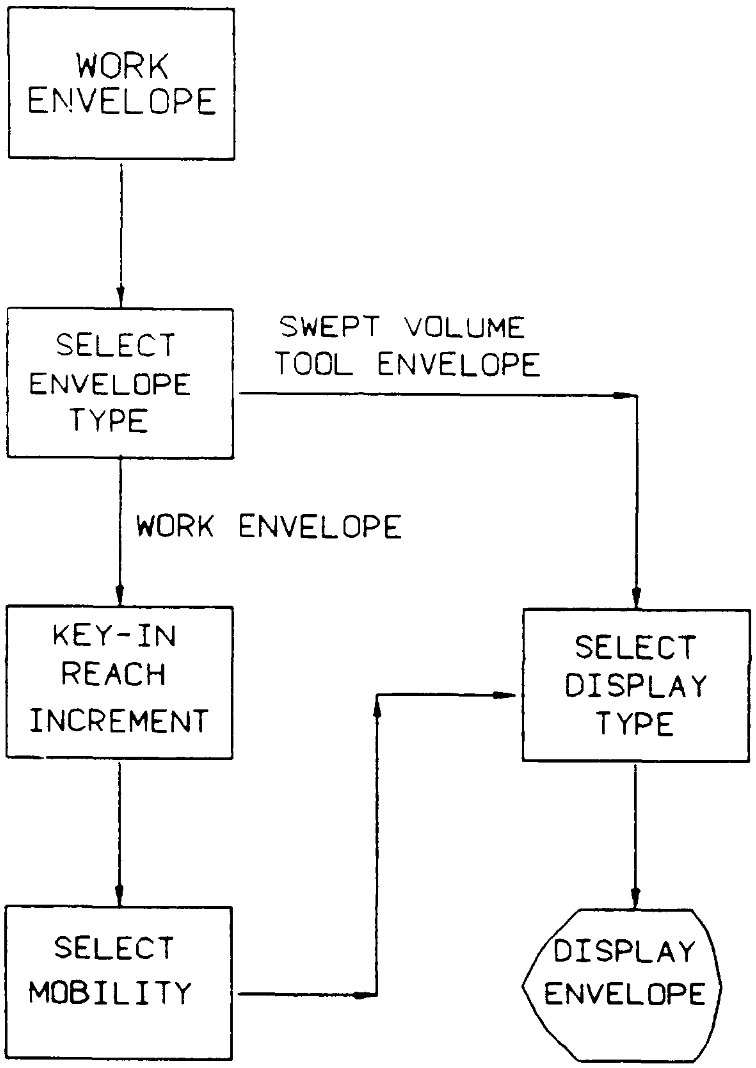


Figure 5.6. Work Envelope Analysis Flow Diagram.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the screen. Another selection is available to the user. If /KEEP/ is selected, OVERLAY becomes the active drawing.

SECTION 6
DISPLAY CURRENT CREW CHIEF DATA FUNCTION

6.1 INTRODUCTION TO DISPLAY CURRENT CREW CHIEF DATA FUNCTION

The Display Current CREW CHIEF Data function displays the selected or default values of the parameters used in the execution of the CREW CHIEF functions. Figure 6.1 shows the format.

6.2 USING THE DISPLAY CURRENT CREW CHIEF FUNCTION

To use the Display Current CREW CHIEF Data function, select the CONFIGURATION icon from the CREW CHIEF Main Programs menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the function to be performed

EXAMPLE: Select the **CONFIGURATION icon**

RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/KEY PAGE

ACTION: Depress the Y/N function key to execute the Configuration function

EXAMPLE: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM CFGUSR EXECUTING appears and then a new prompt appears.

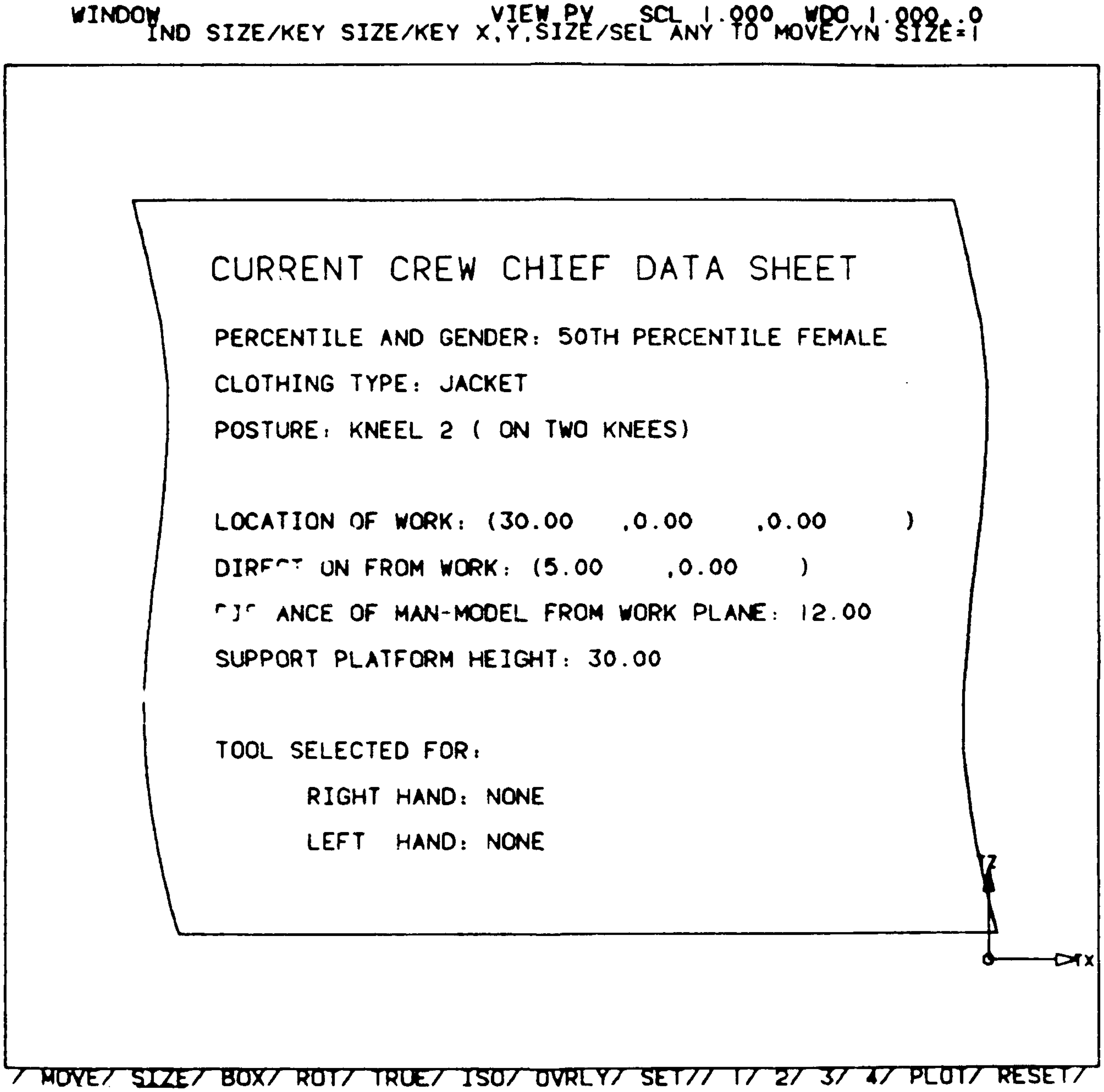


Figure 6.1. Current CREW CHIEF Data Sheet.

PROMPT: DEFINE CENTER OF DATA SHEET

ACTION: Indicate a 2-D point to determine where the center of the current CREW CHIEF data sheet will appear on the screen

RESULT: The current CREW CHIEF data sheet appears on the screen.

After the data sheet appears on the screen, it may be necessary to increase the size of the data sheet to be viewed correctly. This can be accomplished by depressing CADAM's window function key and using the appropriate menu items to view the data sheet. After the user has viewed the plot, he/she should depress the ACCESS PFK to continue any analysis.

Figure 6.2 diagrams the actions necessary to execute a display of the current CREW CHIEF data.

To continue the analysis, the user will generally select **/RECOVER/** from bottom of screen. The CREW CHIEF Main Programs menu will appear. Another option is also available to the user. If /KEEP/ is selected, OVERLAY becomes the active drawing.

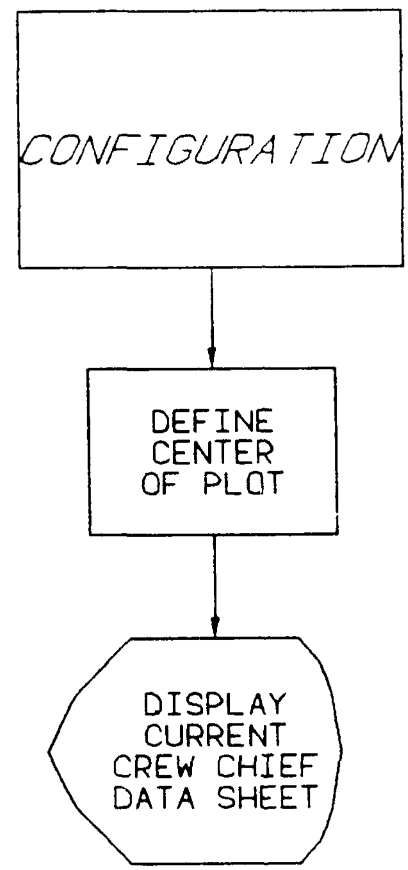


Figure 6.2. Current CREW CHIEF Data Flow Diagram.

SECTION 7

INTERACTIVE HELP CAPABILITIES

7.1 INTRODUCTION TO INTERACTIVE HELP CAPABILITIES

Each CREW CHIEF function includes a series of callable HELP pages, displayed on the screen, to assist in operating the function. These pages give reminders on how to use the function and suggestions concerning the selections to be made, but do not take the place of this user's guide.

The HELP pages cannot be called at will when executing the function. Help is available once a particular CREW CHIEF function is being executed. They can only be called when /HELP/ is displayed in the CADAM-supplied bottom menu.

Once **/HELP/** has been selected, the user will select the **/PAGE FORWARD/** option from the bottom CADAM supplied menu until the desired information is displayed on the screen. To exit HELP the user selects **/EXIT HELP/** from the bottom menu. The CADAM HELP capability has one drawback: the user cannot go directly to the desired HELP page, but instead must wait while each page is sequentially displayed on the screen.

7.2 USING THE INTERACTIVE HELP CAPABILITIES

To call the set of HELP pages for any function:

PROMPT: (These vary from function to function, and always appear at the top of the window.)

ACTION: Select **/HELP/**, when it is available, from the CADAM-supplied bottom menu. It is available once a particular CREW CHIEF function is being activated.

RESULT: First page of HELP available for a particular function is displayed.

To view the next page:

PROMPT: SEL MENU (These vary from function to function and prompt appears at top of page)

ACTION: Select **/PAGE FORWARD/** from the bottom menu

RESULT: Subsequent page is displayed.

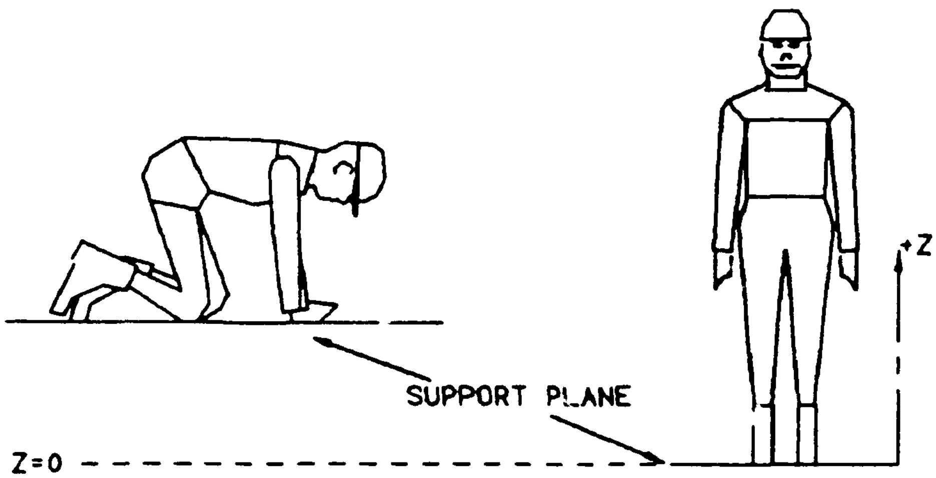
Each succeeding page is accessed by selecting **/PAGE FORWARD/**. When the last page is reached, the /PAGE FORWARD/ selection will display the index page and the order of HELP pages will begin again. The user exits the HELP mode by selecting **/EXIT HELP/** from the bottom menu. The program returns the user back to his/her previous location in the interface of the particular function. Figures 7.1 through 7.7 are typical examples of HELP pages.

TECHNICIAN PARAMETER
HELP TABLE. PAGE 6.
CREW CHIEF, VERSION I

D) PLATFORM HEIGHT:

THE POSITION ALONG THE Z-AXIS OF THE SUPPORT PLANE

** NOTE: PLATFORM HEIGHT MEASURED FROM Z=0,
THEREFORE CAN BE NEGATIVE.



MORE HELP AVAILABLE ON NEXT PAGE

Figure 7.1. CREW CHIEF Initialization Help Page.

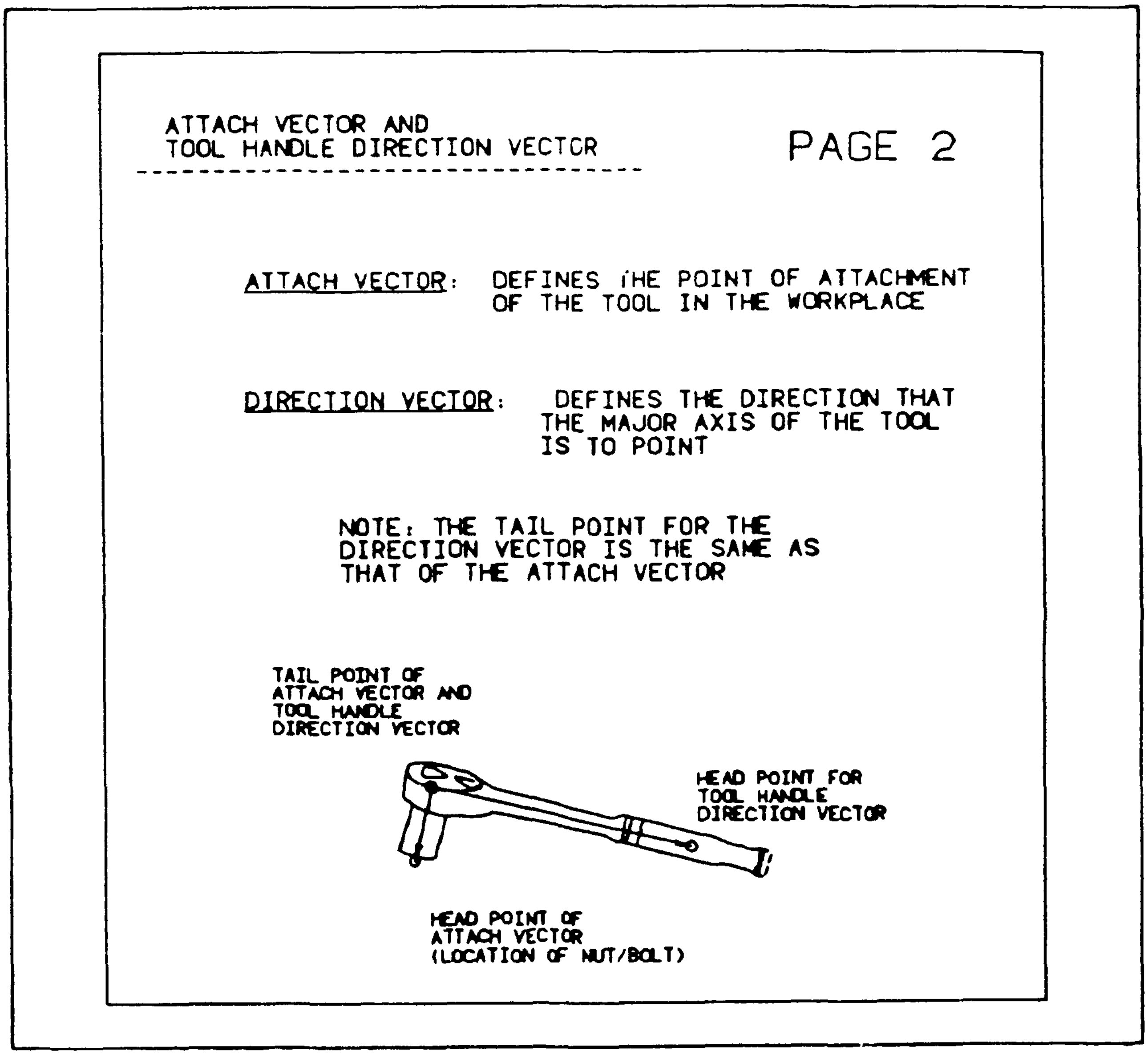


Figure 7.2. CREW CHIEF Tool Analysis Help Page.

MATERIALS HANDLING
HELP TABLE. PAGE 5.
CREW CHIEF, VERSION I

COEFFICIENT OF FRICTION
BETWEEN SHOES AND SURFACE

SURFACE 1	SURFACE 2	μ
RUBBER	RUBBER (WET)	0.5-0.9
RUBBER	RUBBER (DRY)	0.7-1.0
LEATHER	WOOD	0.2-0.5
LEATHER	METAL	0.3-0.6

MORE HELP AVAILABLE ON NEXT PAGE.

Figure 7.3. Coefficient of Friction Help Page.

MATERIALS HANDLING
HELP TABLE. PAGE 4
CREWCHIEF, VERSION I

OBJECT DIMENSIONS:

HEIGHT:

OBJECT'S DIMENSION PERPENDICULAR TO THE SUPPORT PLANE

WIDTH:

OBJECT'S HORIZONTAL DIMENSION PARALLEL TO THE CREW CHIEF'S BODY

DEPTH:

OBJECT'S DIMENSION PERPENDICULAR TO THE CREW CHIEF'S BODY

** NOTE: FOR IRREGULAR OBJECTS, OTHER ELEMENTS BESIDES HEIGHT, WIDTH, & DEPTH MAY BE NEEDED TO DEFINE THE OBJECT'S SURFACE.

MORE HELP AVAILABLE ON NEXT PAGE.

Figure 7.4. Materials Handling Help Page.

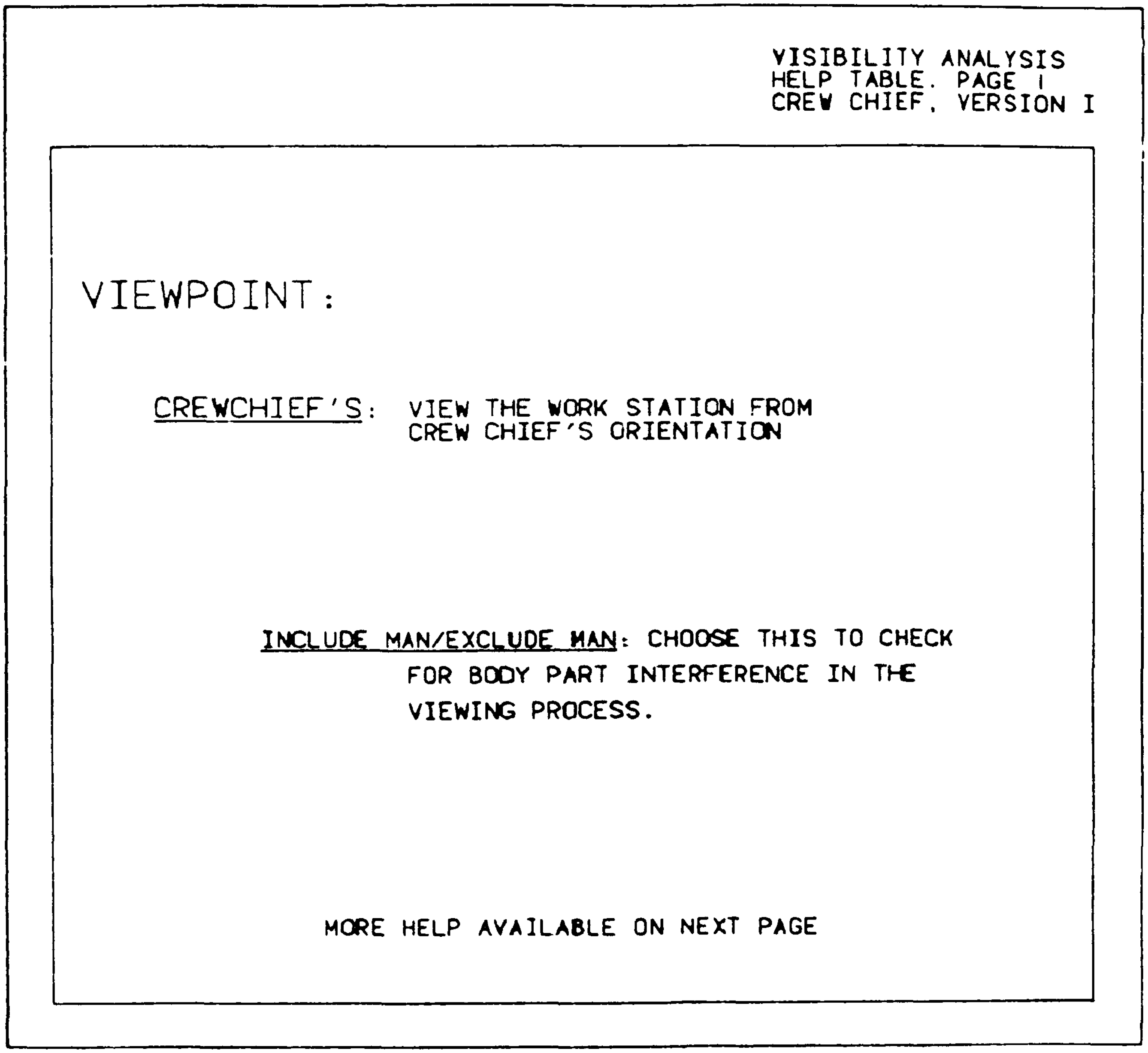


Figure 7.5. CREW CHIEF Visibility Analysis Help Page.

CONNECTOR ANALYSIS
HELP TABLE. PAGE 3.
CREW CHIEF. VERSION I

CENTER OF PLOT

2-DIMENSIONAL CADAM POINT DEFINING WHERE
THE CENTER OF THE STRENGTH TABLE WILL
APPEAR ON THE SCREEN.

DISPLAY TYPE

WIRE: WIRE FRAME MODEL WILL BE DISPLAYED.

FRONT: WIRE FRAME MODEL WITH BACK FACES REMOVED.

PROFILE: WIRE FRAME MODEL WITH BACK FACES AND INTERIOR LINES REMOVED.

REPOSITION: WIRE FRAME MODEL WITH EXTRA LINE SEGMENTS TO AID REPOSITIONING PROCESS.

END OF HELP FOR CONNECTOR ANALYSIS

Figure 7.6. Connector Analysis Help Page.

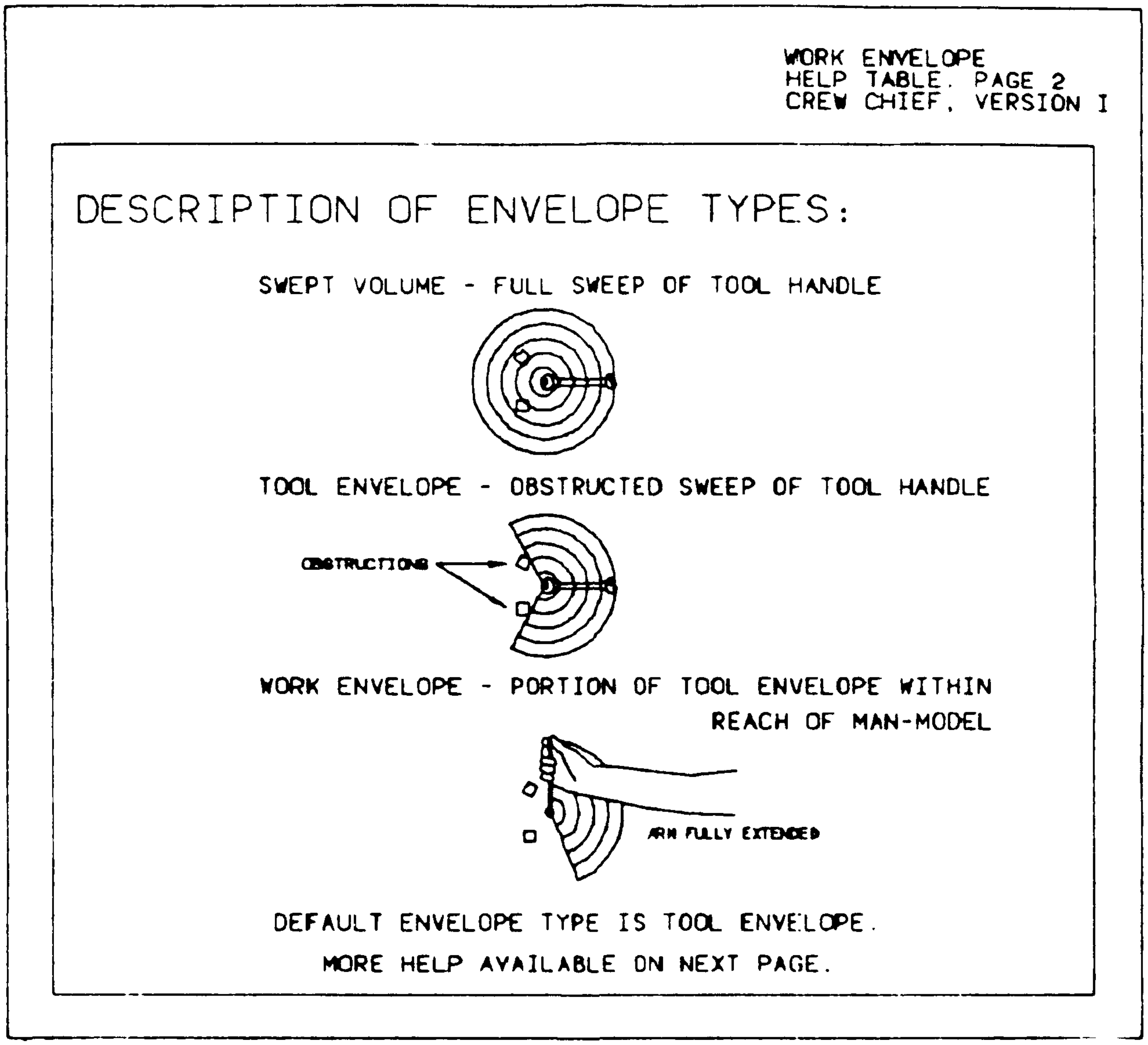


Figure 7.7. Work Envelope Help Table Depicting Difference Between Work Envelope Types.

SECTION 8
QUICK REFERENCE

This Quick Reference Section is provided as an outline of the actions which can be taken for any given function. The Section is divided into each of the eleven different functions. All function prompts begin from the CREW CHIEF Main Programs menu (Figure 1.3). All prompts appear at the top of the window and all menus appears either on the screen or at the bottom of the window.

8.1 CREW CHIEF GENERATION FUNCTIONS

8.1.1 CREW CHIEF Initialization Function

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **GENERATION icon**

RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **INITIALIZATION icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM INIUSR EXECUTING appears and then the Body Size menu appears (Figure 2.2).

PROMPT 4: SELECT DESIRED BODY SIZE

ACTION: Select the icon representing the body size and gender of the man-model (see Appendix A)

RESULT: Clothing menu appears (Figure 2.3).

PROMPT 5: SELECT DESIRED CLOTHING TYPE

ACTION: Select the icon representing the type of clothing to be worn by the man-model (see Appendix B)

RESULT: Posture menu appears (Figure 2.4).

PROMPT 6: SELECT DESIRED POSTURE

ACTION: Select the icon representing the starting posture of the man-model (see Appendix C).

RESULT: Position mode menu appears.

PROMPT 7: SELECT DESIRED POSITION MODE

ACTION 1: Select **NEW POSITION AND ORIENTATION** to define the man-model at a new position and orientation

RESULT: Prompt to define location of work appears.

ACTION 2: Select **OLD POSITION AND ORIENTATION** to place the man-model in the same location and orientation as previously defined during Initialization.

RESULT: Display Type Selection menu appears (Go to Prompt 14).

ACTION 3: Select **CURRENT POSITION AND ORIENTATION** to redisplay the man-model in the current saved position and orientation.

RESULT: Display Type Selection menu appears (Go to Prompt 14).

PROMPT 8: DEFINE POINT FOR LOCATION OF WORK

ACTION: Select an existing 3-D point of the location of work <u>or</u> key in the X,Y,Z coordinates of the location of work **<CR>**

RESULT: Prompt for direction of man-model to work appears.

PROMPT 9: DEFINE POINT FOR DIRECTION FROM WORK

ACTION: Select an existing point to define the direction point or key in the X,Y,Z coordinates of the direction point **<CR>**

RESULT: Prompt to key in distance from work appears.

PROMPT 10: KEY IN DISTANCE FROM WORK

ACTION: Key in distance from work **<CR>**

RESULT: Menu for defining mode to input platform height appears.

PROMPT 11: SELECT PLATFORM INPUT MODE

ACTION 1: Choose **SELECT WORK PLATFORM POINT** to define an existing 3-D point in the drawing.

RESULT: Prompt to select platform height from drawing appears.

ACTION 2: Select **KEY IN PLATFORM HEIGHT** to key in the height of the support platform.

RESULT: Prompt to key in platform height appears (Go to Prompt 13).

PROMPT 12: DEFINE POINT ON PLATFORM

ACTION: Select an existing 3-D point (Z coordinate).

RESULT: Display Type menu appears (Go to Prompt 14).

PROMPT 13: KEY IN PLATFORM HEIGHT

ACTION: Key in platform height (Z coordinate) **<CR>.**

RESULT: Display Type menu appears.

PROMPT 14: SELECT DESIRED DISPLAY TYPE

ACTION: Select a display type (see Table 2.1)

RESULT: Man-model appears superimposed on the drawing in size-gender, posture, clothing, and display type chosen; a CADAM menu appears.

PROMPT 15: SEL MENU

ACTION: Select **/RECOVER/** to return to the CREW CHIEF Generation Functions menu (Figure 2.1)

RESULT: Program returns to CREW CHIEF Generation Functions menu (Figure 2.1).

8.1.2 CREW CHIEF Regeneration Function

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **GENERATION icon**

RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **REGENERATION icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM REGUSR EXECUTING appears and then the Display Type menu appears.

PROMPT 4: SELECT DESIRED DISPLAY TYPE

ACTION: Select a display type (see Table 2.1)

RESULT: Man-model appears on the drawing in the display type chosen and as it did in the last successful generation; a CADAM menu appears.

PROMPT 5: SEL MENU

ACTION: Select **/RECOVER/** to return to the CREW CHIEF Generation Functions menu (Figure 2.1)

RESULT: Program returns to CREW CHIEF Generation Functions menu (Figure 2.1).

8.1.3 CREW CHIEF Reposition Function

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **GENERATION icon**

RESULT: The CREW CHIEF Generation Functions menu is displayed (see Figure 2.1).

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **REPOSITION icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM RPNUSR EXECUTING appears, man-model is initialized in the last successful positioning and appears in the drawing, and then a new prompt appears.

PROMPT 4: SELECT THE OPTION YOU WISH TO USE

ACTION 1: Select **REORIENT A MAN-MODEL SEGMENT** to rotate and/or twist specific segments of the man-model

RESULT: Prompt to select man-model segment to reorient appears.

ACTION 2: Select **DEFINE NEW POSITION REFERENCE POINT** to define a new position reference point on the man-model. Figure 2.6 defines the position reference point for each posture.

RESULT: Prompt to define new position reference point appears (Go to Prompt 11).

ACTION 3: Select **REORIENT THE ENTIRE MAN-MODEL** to define a new support platform or rotate entire man-model.

RESULT: Menu to tilt support or rotate the entire man-model appears (Go to Prompt 12).

ACTION 4: Select **SQUAT FROM AN UPRIGHT POSTURE** to allow the man-model to be positioned in a squat posture.

RESULT: Prompt to key in angle of knees appears (Go to Prompt 16).

PROMPT 5: SELECT MAN-MODEL SEGMENT YOU WISH TO REORIENT

ACTION: Select the body segment you wish to to flex or twist. The user may select one of the options from the bottom menu at any time.

RESULT 1: Menu to select option for flexing or twisting selected segment appears.

RESULT 2: New main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu. The man-model has been repositioned at this time) (Go to Prompt 9).

RESULT 3: Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu without repositioning the man-model) (Go to Prompt 4).

PROMPT 6: SELECT THE OPTION YOU WISH TO USE

ACTION: Select option whether to flex or twist the selected segment. If the user is satisfied with the location of a specified segment he may select one of the options from the bottom menu.

RESULT 1: Prompt to key in the angle of flexion appears (Result of choosing FLEX).

RESULT 2: Prompt to key in the angle of twist appears (Result of choosing TWIST) (Go to Prompt 10).

RESULT 3: Prompt to select man-model to reorient appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu) (Go to Prompt 5).

PROMPT 7: KEY IN INCREMENT FOR FLEXED ANGLE IN DEGREES

ACTION: Key in the angle of flexion in degrees **<CR>**. The default is ten degrees and can be obtained by **<CR>**.

RESULT: Man-model reappears on screen with selected body segment flexed by amount of degrees specified. Then prompt to key in new angle appears.

PROMPT 8: KEY IN INCREMENT FOR THE FLEXED ANGLE IN DEGREES

ACTION: Key in a new angle of flexion or rotation or **<CR>** for same angle. If the user is satisfied with the location of the body segment, he can select **/TO PREVIOUS MENU/** from the bottom menu. This will return him to a new menu.

RESULT 1: Man-model reappears on screen with selected body segment flexed or rotated by amount of degrees specified. This same prompt stays active (Result of keying in a new angle). (Go to Prompt 8.)

RESULT 2: Menu to select Flex or Twist man-model segment appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu) (Go to Prompt 6).

PROMPT 9: SELECT THE OPTION YOU WISH TO USE

ACTION 1: Select **ABORT CURRENT MAN-MODEL AND RECOVER** to recover position of man-model before last save command was given

RESULT: Main menu appears (Go to Prompt 4).

ACTION 2: Select **REORIENT A MAN-MODEL SEGMENT** to rotate and/or flex specific segments of the man-model

RESULT: Prompt to select man-model segment to reorient appears. (Go to Prompt 5).

ACTION 3: Select **DEFINE NEW POSITION REFERENCE POINT** to define a new position reference point on the man-model. Figure 2.6 defines the position reference point for each posture.

RESULT: Prompt to define new position reference point appears (Go to Prompt 11).

ACTION 4: Select **REORIENT THE ENTIRE MAN-MODEL** to define a new support platform or rotate entire man-model.

RESULT: Menu to tilt support or rotate the entire man-model appears (Go to Prompt 12).

ACTION 5: Select **SQUAT FROM AN UPRIGHT POSTURE** to allow the man-model to be positioned in a squat posture.

RESULT: Prompt to key in angle of knees appears (Go to Prompt 16).

ACTION 6: Select **/EXIT FUNCTION/** from bottom menu to exit Reposition function.

RESULT 1: Menu option to save current man-model or exit function without saving appears (Result of repositioning the man-model) (Go to Prompt 17).

RESULT 2: CADAM menu appears (Result of not repositioning the man-model after saving) (Go to Prompt 18).

PROMPT 10: KEY IN INCREMENT FOR TWISTED ANGLE IN DEGREES

ACTION: Key in the angle of twist in degrees **<CR>**. The default is ten degrees and can be obtained by **<CR>**. If the user is satisfied with the location of the body segment he can select /TO PREVIOUS MENU/ from the bottom menu

RESULT 1: Man-model reappears on screen with selected body segment twisted by amount of degrees specified. This same Prompt stays active (Result of keying in new angle) (Go to Prompt 10).

RESULT 2: Menu to select flex or twist man-model segment appears (Result of choosing /TO PREVIOUS MENU/ from bottom screen) (Go to Prompt 6).

PROMPT 11: DEFINE NEW POSITION REFERENCE POINT

ACTION: Select an existing 3-D point to define the new position reference point or key in the X,Y,Z coordinates to define the new position reference point **<CR>**. If the user is satisfied with the position reference point, he can select /TO PREVIOUS MENU/ from the bottom menu

RESULT 1: Man-model reappears moved to the new position reference point. Same prompt appears. (Go to prompt 11).

RESULT 2: New main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu. The man-model has been repositioned at this time) (Go to Prompt 9).

RESULT 3: Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu without repositioning the man-model) (Go to Prompt 4).

PROMPT 12: SELECT OPTION YOU WISH TO USE

ACTION 1: Select **TILT THE SUPPORT PLATFORM**

RESULT: Prompt to select the tilting axis appears.

ACTION 2: Select **ROTATE THE ENTIRE MAN-MODEL**

RESULT: Prompt to key in angle to rotate man-model appears. (Go to prompt 15.)

ACTION 3: Select /TO PREVIOUS MENU/ to return to previous menu

RESULT 1: New Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu. The man-model has been repositioned at this time) (Go to Prompt 9).

RESULT 2: Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu without repositioning the man-model (Go to Prompt 4).

PROMPT 13: SELECT THE TILTING AXIS YOU WISH TO USE

ACTION: Select a line segment representing the tilting axis. If the user is satisfied with the tilt of the support platform, he can select to previous menu from the bottom menu.

RESULT 1: Prompt to key in angle to tilt platform appears.

RESULT 2: Menu to tilt the support platform or rotate the entire man-model appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu (Go to Prompt 12).

PROMPT 14: KEY IN INCREMENT FOR TILTED ANGLE IN DEGREES

ACTION: Key in the angle to tilt the support platform. The default is 10 degrees and can be obtained by **<CR>**. If the user is satisfied with the tilt of the support platform he can choose /TO PREVIOUS MENU/ from the bottom menu.

RESULT 1: Man-model reappears moved onto new support platform. Same prompt appears (Go to Prompt 14).

RESULT 2: Prompt to select tilted axis appears (Result of choosing /TO PREVIOUS MENU/) (Go to Prompt 13).

PROMPT 15: KEY IN ANGLE TO ROTATE MAN-MODEL IN DEGREES

ACTION: Key in angle to rotate the man-model. The default is 10 degrees and can be obtained by **<CR>**. If the user is satisfied with the position of the man-model he can select /TO PREVIOUS MENU/ from the bottom menu.

RESULT 1: Man-model is rotated by angle specified. Same Prompt appears (Go to Prompt 15).

RESULT 2: Menu to tilt the support platform or rotate the entire man-model appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu) (Go to Prompt 12).

PROMPT 16: KEY IN THE DESIRED KNEE ANGLE IN DEGREES

ACTION: Key in angle needed for bending the knees. If the user is satisfied with the position of the man-model he can select /TO PREVIOUS MENU/ from bottom menu.

RESULT 1: This same prompt appears to key in another angle (Result of keying in another angle). (Go to Prompt 16.)

RESULT 2: New main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu. The man-model has been repositioned at this time) (Go to Prompt 9).

RESULT 3: Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu without repositioning the man-model) (Go to Prompt 4).

PROMPT 17: SELECT THE OPTION YOU WISH TO USE

ACTION 1: Select **SAVE THE MAN-MODEL AND RESUME THE FUNCTION**

RESULT: Main menu appears (Go to Prompt 4).
ACTION 2: Select **SAVE THE MAN-MODEL AND EXIT THE FUNCTION**

RESULT: CADAM menu appears.

ACTION 3: Select **EXIT FUNCTION WITHOUT SAVING**

RESULT: CADAM menu appears

PROMPT 18: SEL MENU

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/RECOVER/** will return the user to the CREW CHIEF Generation Functions

RESULT: Program returns to CREW CHIEF Generation Functions menu.

8.1.4 <u>CREW CHIEF Head Orientation Function</u>

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **GENERATION icon**

RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **HEAD ORIENTATION icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM HDOUSR EXECUTING appears and then prompt to define target point appears.

PROMPT 4: DEFINE TARGET POINT

ACTION: Select an existing 3-D point to define the target point <u>or</u> key in X,Y,Z coordinates of the target point **<CR>**

RESULT: Display type menu appears.

PROMPT 5: SELECT DESIRED DISPLAY TYPE

ACTION: Select a display type (see Table 2.1)

RESULT: Man-model appears superimposed in the display type chosen, with its head oriented toward the target point; CADAM menu appears.

PROMPT 6: SEL MENU

ACTION: Select **/RECOVER/** to return to the CREW CHIEF Generation Functions menu (Figure 2.1)

RESULT: Program returns to CREW CHIEF Generation Functions menu (Figure 2.1).

8.2 MAINTENANCE TASK ANALYSES

8.2.1 <u>CREW CHIEF Tool Analysis Function</u>

8.2.1.1 Wrenches Without Sockets: Open End, Combination End, Standard Box End, Deep Offset Box End, Ratcheting Box End, and Allen

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TOOL ANALYSIS icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears and then Tool Selection menu (Figure 3.2) appears.

PROMPT 4: SELECT TOOL CLASS

ACTION: Select **WRENCHES** from menu

RESULT: Wrench Selection menu (Figure 3.3) appears.

PROMPT 5: SELECT WRENCHES

ACTION: Select a type of wrench from the menu

RESULT: Bolt diameter menu appears.

PROMPT 6: SELECT BOLT DIAMETER

ACTION: Select the size corresponding to bolt diameter to be used in the analysis

RESULT 1: Hand Selection menu (Figure 3.5) appears (Result of selecting a bolt diameter that will need a large enough wrench to use one or both hands).

RESULT 2: Hand Selection menu (Figure 3.16) appears (Result of selecting a bolt diameter that will need a small wrench).

PROMPT 7: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool

RESULT: Grip Selection menu appears.

PROMPT 8: SELECT GRIP TYPE

ACTION: Select the grip type to be used

RESULT: Prompt to define head point of attach vector appears.

PROMPT 9: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the bolt head or key in X,Y,Z coordinates which define center point of bolt head **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 10: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the orientation of bolt axis or key in the X,Y,Z coordinates of bolt axis

RESULT: Prompt to define direction of tool handle appears.

PROMPT 11: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Select an existing 3-D point to define the tool handle direction or key in X,Y,Z coordinates of handle direction point **<CR>**

RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 12: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT 1: Prompt for center of plot appears (Result of choosing a wrench that has strength information).

RESULT 2: Obstacle Avoidance menu appears (Result of choosing an allen wrench which has no strength information). (Go to Prompt 14.)

PROMPT 13: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen.

RESULT: Menu for obstacle avoidance appears.

PROMPT 14: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display Type menu appears.

PROMPT 15: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If task is successful, man-model appears on the drawing performing the task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 16: SEL MENU

ACTION: Select **/RECOVER/** from bottom menu to continue any analysis

RESULT: Task Analysis Function menu (Figure 3.1) appears.

8.2.1.2 Wrenches With Sockets: Breaker Bar, Torque, Ratchet, and Speedhandle

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TOOL ANALYSIS icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears and then Tool Selection menu (Figure 3.2) appears.

PROMPT 4: SELECT TOOL CLASS

ACTION: Select **WRENCHES** from menu

RESULT: Wrench Selection menu (Figure 3.3) appears.

PROMPT 5: SELECT WRENCHES

ACTION: Select a type of wrench from the menu

RESULT 1: Extension menu (Figure 3.9) appears (Result of selecting ratchet, torque or breaker bar).

RESULT 2: Socket Selection menu (Figure 3.10) appears (Result of selecting speedhandle). (Go to Prompt 7.)

PROMPT 6: SELECT EXTENSION

ACTION: Select desired extension length

RESULT: Socket Type menu (Figure 3.10) appears.

PROMPT 7: SELECT SOCKET

ACTION: Select desired socket type

RESULT: Drive Size menu appears.

PROMPT 8: SELECT DRIVE SIZE

ACTION: Select the range corresponding to the bolt diameter to be used in the analysis. The drive size of the socket may be selected instead of the bolt diameter.

RESULT: Head size selection menu appears.

PROMPT 9: SELECT HEAD SIZE

ACTION: Select the size corresponding to the bolt head

RESULT 1: Tool handle selection menu appears.

RESULT 2: GRIP Type Selection menu appears (Result of choosing a speedhandle) (Go to Prompt 12).

PROMPT 10: SELECT HANDLE LENGTH

ACTION: Select the length of the wrench handle (regular or long) to be used in the analysis

RESULT: Hand Type Selection menu (Figure 3.5) appears.

PROMPT 11: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool
RESULT: Grip Type Selection menu appears.

PROMPT 12: SELECT GRIP TYPE

ACTION: Select the grip type to be used

RESULT: Prompt to define head point of attach vector appears.

PROMPT 13: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the center point of bolt head or key in X,Y,Z

coordinates which define center point of bolt head **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 14: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the orientation of the bolt axis or key in the X,Y,Z coordinates to define the orientation of the bolt axis **<CR>**

RESULT: Prompt to define direction of tool handle appears.

PROMPT 15: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Select an existing 3-D point to define the tool handle direction <u>or</u> key in X,Y,Z coordinates of the tool handle direction point **<CR>**

RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 16: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of mobility types to be used during the Reach analysis

RESULT 1: Prompt for center of plot appears (Result of choosing a wrench which has a torque table to be displayed).

RESULT 2: Menu for obstacle avoidance appears (Result of choosing a speed handle). (Go to Prompt 18.)

PROMPT 17: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen

RESULT: Menu for obstacle avoidance appears.

PROMPT 18: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display type menu appears.

PROMPT 19: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If task is successful, man-model along with table (if applicable) appears on the drawing performing the task; CADAM menu appears.

RESULT 2: If task is unsuccessful because the distance from the man-model to the task is too great, then man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 20: SEL MENU

ACTION: Select **/RECOVER/** to continue any analysis

RESULT: Task Analysis Function menu (Figure 3.1) appears.

8.2.1.3 Screwdrivers: Flat Bladed and Offset

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TOOL ANALYSIS icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears and then Tool Selection menu (Figure 3.2) appears.

PROMPT 4: SELECT TOOL CLASS

ACTION: Select **SCREWDRIVERS** from menu

RESULT: Screwdriver Selection menu (Figure 3.14) appears.

PROMPT 5: SELECT SCREWDRIVERS

ACTION1: Select type of screwdriver to be used in the analysis

RESULT: Blade Length Selection menu appears.

PROMPT 6: SELECT BLADE LENGTH

ACTION: Select blade length to be used in the analysis

RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 7: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool

RESULT: Grip Selection menu appears.

PROMPT 8: SELECT GRIP TYPE

ACTION: Select the grip type to be used

RESULT: Prompt to define head point of attach vector appears.

PROMPT 9: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the center point of attachment or key in X,Y,Z coordinates which define center point of attachment **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 10: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the orientation of the screw axis or key in the X,Y,Z coordinates to define the orientation of the screw axis <CR>

RESULT 1: Mobility Type Selection menu (Figure 3.7) appears (Result of choosing a flat bladed screwdriver). (Go to Prompt 12.)

RESULT 2: Prompt to define direction of tool handle appears (Result of choosing OFFSET screwdriver).

PROMPT 11: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Select an existing 3-D point to define the direction of tool handle or key in the

X,Y,Z coordinates to define the direction of the tool handle <CR>

RESULT: Mobility Type Selection menu (Figure 3.7) appears.

PROMPT 12: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select the mobility type to be used during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 13: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display Type menu appears.

PROMPT 14: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 15: SEL MENU

ACTION: Select **/RECOVER/** to continue any analysis

RESULT: Task Analysis Function menu (Figure 3.1) appears.

8.2.1.4 Pliers: Combination, Needle Nose, Safety, Adjustable, and Wire Cutters

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TOOL ANALYSIS icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears and then Tool Selection menu (Figure 3.2) appears.

PROMPT 4: SELECT TOOL CLASS

ACTION: Select **PLIERS** from menu
RESULT: Pliers Selection menu (Figure 3.19) appears.

PROMPT 5: SELECT PLIERS

ACTION: Select the type of pliers to be used in the analysis from menu

RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 6: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool

RESULT: Grip Type Selection menu appears.

PROMPT 7: SELECT GRIP TYPE

ACTION: Select the grip type to be used

RESULT: Prompt to define head point of attach appears.

PROMPT 8: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the center point of attachment or key in X,Y,Z coordinates which define center point of attachment **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 9: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the direction of the point of attachment or key in the X,Y,Z coordinates to define the direction of the point of attachment **<CR>**

RESULT: Prompt to define direction of tool handle appears.

PROMPT 10: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Select an existing 3-D point to define the direction of tool handle or key in X,Y,Z coordinates of the direction of tool handle **<CR>**

RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 11: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select the mobility type to use during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 12: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display Type menu appears.

PROMPT 13: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 14: SEL MENU

ACTION: Select **/RECOVER/** to continue any analysis

RESULT: Task Analysis Function menu (Figure 3.1) appears.

8.2.1.5 Miscellaneous Tools: Nutdriver, Hammer, File, Scraper, Hacksaw, Drill, and Sander

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TOOL ANALYSIS icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears and then Tool Selection menu (Figure 3.2) appears.

PROMPT 4: SELECT TOOL CLASS

ACTION: Select **MISCELLANEOUS** from menu

RESULT: Miscellaneous Selection menu (Figure 3.22) appears.

PROMPT 5: SELECT MISCELLANEOUS TOOLS

ACTION: Select the tool to be used in the analysis

RESULT 1: Hand selection menu (Figure 3.16) appears (Result of choosing scraper, hacksaw, or drill). (Go to Prompt 8.)

RESULT 2: Prompt to define head point of attach vectors appears (Result of choosing file or sander). (Go to Prompt 10.)

RESULT 3: Chisel Selection Menu appears (Result of choosing a hammer).

RESULT 4: Bolt Diameter Selection menu for nutdriver appears (Result of choosing a nutdriver). (Go to Prompt 7).

PROMPT 6: SELECT CHISEL

ACTION: Select option to decide if chisel is to be used with the hammer in the analysis

RESULT: Hand Selection menu (Figure 3.16) appears. (Go to Prompt 8.)

PROMPT 7: SELECT BOLT DIAMETER

ACTION: Select the size corresponding to the bolt diameter to be used in analysis

RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 8: SELECT HAND TO BE USED DURING TASK

ACTION: Select which hand will hold the tool

RESULT 1: Prompt for head point of attach vector appears. (Go to Prompt 10.)

RESULT 2: Grip Type Selection menu for nutdriver appears.

PROMPT 9: SELECT GRIP TYPE

ACTION: Select the grip to be used in the analysis

RESULT: Prompt for head point of attach vector appears.

PROMPT 10: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the center point of attachment or key in X,Y,Z coordinates which define center point of attachment **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 11: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the direction of the point of attachment or key in the X,Y,Z coordinates to define the direction of the point of attachment **<CR>**

RESULT 1: Prompt to define direction of tool handle appears.

RESULT 2: Mobility Type menu (Figure 3.7) appears. (Result of choosing a Nutdriver or File). (Go to prompt 13.)

PROMPT 12: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Select an existing 3-D point to define the direction of tool handle or key in X,Y,Z coordinates of the direction of tool handle **<CR>**

RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 13: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select the mobility type to be used during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 14: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display Type menu appears.

PROMPT 15: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 16: SEL MENU

ACTION: Select **/RECOVER/** to continue any analysis

RESULT: Task Analysis Function menu (Figure 3.1) appears.

8.2.2 Materials Handling Analysis Function

8.2.2.1 Carry

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **MATERIALS HANDLING icon**

RESULT: Materials Handling menu (Figure 3.24) appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **CARRY icon**

RESULT: New prompt appears.

PROMPT 4: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM CRYUSR EXECUTING appears and then the Handle Selection menu (Figure 3.25) appears.

PROMPT 5: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select the number of handles to be used

RESULT 1: Menu to select process for defining ceiling height appears (Result of selecting NO HANDLES or TWO HANDLES). (Go to Prompt 7.)

RESULT 2: Arm Selection menu (Figure 3.27) appears (Result of selecting ONE HANDLE).

PROMPT 6: SELECT ARM TO BE USED DURING TASK

ACTION: Select which arm will perform task

RESULT: Menu to select mode for defining ceiling height appears.

PROMPT 7: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING CEILING DEFINITION

ACTION: Select mode for defining the ceiling height

RESULT 1: Prompt to select ceiling height appears (Result of choosing SELECT ELEMENT TO DETERMINE CEILING HEIGHT). (Go to Prompt 9.)

RESULT 2: Prompt to key in ceiling height appears (Result of choosing KEY IN CEILING HEIGHT).

PROMPT 8: KEY IN CEILING HEIGHT

ACTION: Key in value which represents ceiling height **<CR>**

RESULT: Prompt to key in object height appears. (Go to Prompt 10.)

PROMPT 9: SELECT ELEMENT TO DEFINE CEILING HEIGHT

ACTION: Select element (line or 2-point spline) in drawing to represent ceiling height

RESULT: Prompt to key in object height appears.

PROMPT 10: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in value representing height of object **<CR>**

RESULT: Prompt to key in object width appears.

PROMPT 11: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 12: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in value representing depth of object **<CR>**

RESULT: Prompt to indicate Center of Plot Table appears.

PROMPT 13: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 14: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 15: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If carry is successful, man-model along with strength table appears on the drawing in the final carry position; CADAM menu appears.

RESULT 2: If carry is unsuccessful because the distance from the man-model to the object is too great, then man-model appears on drawing attempting to perform carry; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the element selected to define a ceiling was not a line segment or a two-point spline, then the CARRY Task is abandoned and the message "ILLEGAL ELEMENT SELECTED" appears.

RESULT 5: If the line selected to define the ceiling height is parallel to the plane which bisects the man-model into right and left halves, then no intersection point can be found, the ceiling height remains undefined, the CARRY Task is abandoned, and the message "LINE DEFINING CEILING DOES NOT CROSS MAN-MODEL PATH" appears.

RESULT 6: If the object height is greater than the ceiling height, then the CARRY Task is abandoned and the message "OBJECT DOES NOT FIT UNDER CHOSEN CEILING" appears.

RESULT 7: If the ceiling height is less than thirty percent of the current man-model's stature, then no data have been gathered for the chosen ceiling height and the message "CEILING TOO LOW RELATIVE TO CURRENT MAN-MODEL SIZE" appears.

PROMPT 16: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials Handling Tasks menu

RESULT: Materials Handling Tasks menu (Figure 3.24) appears.

8.2.2.2 Hold

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **MATERIALS HANDLING icon**

RESULT: Materials Handling menu (Figure 3.24) appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **HOLD icon**

RESULT: New prompt appears.

PROMPT 4: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM HLDUSR EXECUTING appears and then the Arm Selection menu (Figure 3.27) appears.

PROMPT 5: SELECT ARM TO BE USED DURING TASK

ACTION: Select which arm will hold the object

RESULT: Mobility Selection menu (Figure 3.7) appears.

PROMPT 6: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the Reach Analysis

RESULT: Menu to select type of support object is to be held against appears.

PROMPT 7: SELECT TYPE OF SUPPORT OBJECT IS TO BE HELD AGAINST

ACTION: Select which Hold Task Type to use during the analysis

RESULT 1: Menu to define mode for defining object appears (Result of choosing HOLD AGAINST CEILING). (Go to Prompt 12.)

RESULT 2: Barrier Selection menu appears (Result of choosing HOLD AGAINST WALL).

PROMPT 8: SELECT TYPE OF BARRIER INVOLVED IN HOLD TASK

ACTION: Choose a type of barrier

RESULT 1: Menu to select mode for object dimensions appears (Result of choosing NO BARRIER INVOLVED or VERTICAL BARRIER BETWEEN OBJECT AND CREW CHIEF). (Go to Prompt 12.)

RESULT 2: Menu to select mode for defining ceiling height appears (Result of choosing CEILING BARRIER CAUSES UNUSUAL POSTURE).

PROMPT 9: SELECT WHICH TYPE OF PROCESS TO USE FOR CEILING DEFINITION

ACTION: Select process to define ceiling height

RESULT 1: Prompt to select ceiling height appears. (Result of choosing SELECT ELEMENT TO DETERMINE CEILING HEIGHT). (Go to Prompt 11.)

RESULT 2: Prompt to key in ceiling height appears (Result of choosing KEY IN CEILING HEIGHT).

PROMPT 10: KEY IN CEILING HEIGHT

ACTION: Key in value which represents the ceiling height

RESULT: Menu to select mode for object dimensions appears. (Go to Prompt 12.)

PROMPT 11: SELECT ELEMENT TO DEFINE CEILING HEIGHT

ACTION: Select element from screen which represents the ceiling height

RESULT: Menu to select mode for object dimensions appears.

PROMPT 12: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Choose type of process for defining object dimensions

RESULT 1: Prompt to key in object height appears. (Result of choosing KEY IN OBJECT DIMENSIONS). (Go to Prompt 17.)

RESULT 2: Prompt to select object height appears (Result of choosing SELECT OBJECT FROM SCREEN).

PROMPT 13: SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 14: SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 15: SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 16: SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT: Prompt to indicate center of plot for strength table appears. (Go to Prompt 24.)

PROMPT 17: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in value representing height of object **<CR>**

RESULT: Prompt to key in object width appears.

PROMPT 18: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 19: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in value representing depth of object **<CR>**

RESULT 1: Prompt to select line defining height direction appears. (Result of selecting HOLD AGAINST WALL.) (Go to Prompt 21.)

RESULT 2: Prompt to select line defining depth direction appears. (Result of selecting HOLD AGAINST CEILING.)

PROMPT 20: SELECT LINE DEFINING DEPTH DIRECTION OF OBJECT

ACTION: Select a line in the drawing which defines the direction of the depth dimension of the object

RESULT: Prompt to select width of attach plane appears. (Go to Prompt 22.)

PROMPT 21: SELECT LINE DEFINING HEIGHT DIRECTION OF OBJECT

ACTION: Select a line in the drawing which defines the direction of the height dimension of the object

RESULT: Prompt to select width of attach plane appears.

PROMPT 22: SELECT LINE DEFINING WIDTH DIRECTION OF OBJECT

ACTION: Select element in the drawing to represent second line defining attach plane

RESULT: Prompt to define attach point of object appears.

PROMPT 23: DEFINE ATTACH POINT OF THE OBJECT ON PLANE OF ATTACHMENT

ACTION: Select an existing 3-D point to define coordinates of the object's attach point, or key in X,Y,Z coordinates of object's attach point **<CR>**

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 24: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 25: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display type menu appears.

PROMPT 26: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If hold is successful, man-model along with strength table appear on the drawing in the final hold position: CADAM-supplied menu appears.

RESULT 2: If hold is unsuccessful because the distance from the man-model to the object is too great, then the man-model appears on drawing attempting to perform hold; missed distance appears on screen; CADAM-supplied menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM-supplied menu appears.

RESULT 4: If a line segment chosen for defining the ceiling height runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; thus the ceiling height remains undefined and the message "LINE DEFINING CEILING HEIGHT DOES NOT INTERSECT MAN-MODEL PLANE" appears.

RESULT 5: If the ceiling and/or the current posture combination does not relate to the current strength data, the Hold task is abandoned and the message "POSTURE AND OBJECT HEIGHT NOT COMPATIBLE WITH PRESENT DATA" appears.

RESULT 6: If any part of the object lies above the ceiling, then the Hold task is abandoned and the message "TOP OF OBJECT GREATER THAN THE USER INPUT CEILING HEIGHT" appears.

RESULT 7: If any one of the object dimensions input is <1 inch, then the Hold task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR THIS SIZE OBJECT" appears.

RESULT 8: If the user has selected or created an object which is impossible for the man-model to reach, then the Hold task is abandoned and the message "SELECTED OBJECT DEFINES DISTANCES TOO LARGE TO REACH" appears.

RESULT 9: If the user picks two line segments which run in the same direction (or exactly opposite directions) to define the attach plane for the object, then the HOLD Task is abandoned and the message "ATTACH PLANE DEFINED IMPROPERLY" appears.

PROMPT 27: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials Handling menu

RESULT: Materials Handling menu (Figure 3.24) appears.

8.2.2.3 Lift

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **MATERIALS HANDLING icon**

RESULT: Materials Handling menu (Figure 3.24) appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **LIFT icon**

RESULT: New prompt appears.

PROMPT 4: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM LFTUSR EXECUTING appears and then the Handle Selection menu (Figure 3.25) appears.

RESULT: Handle Type Selection menu (Figure 3.29) appears.

PROMPT 5: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select number of handles during lift task

RESULT 1: Arm Selection Menu (Figure 3.27) appears (Result of choosing ONE HANDLE).

RESULT 2: Mobility Type Selection menu (Figure 3.7) appears (Result of choosing NO HANDLES). (Go to Prompt 7.)

PROMPT 6: SELECT ARM TO BE USED DURING TASK

ACTION: Select which arm will lift the object

RESULT: Mobility Type Selection menu (Figure 3.7) appears.

PROMPT 7. SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Menu for process to define object appears.

PROMPT 8: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select mode for defining the dimensions of the object

RESULT 1: Prompt to key in object height appears (Result of choosing KEY IN OBJECT DIMENSION). (Go to Prompt 13.)

RESULT 2: Prompt to select object height appears (Result of choosing SELECT OBJECT FROM SCREEN).

PROMPT 9: SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 10: SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 11: SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 12: SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT 1: Prompt to define first endpoint of handle appears (Result of choosing ONE HANDLE). (Go to Prompt 20.)

RESULT 2: Prompt to indicate Center of Plot Table appears. (Go to Prompt 22.)

PROMPT 13: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in value representing height of object **<CR>**
RESULT: Prompt to key in object width appears.

PROMPT 14: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 15: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in value representing depth of object **<CR>**

RESULT: Menu for selecting mode to define lift distance appears.

PROMPT 16: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR OBJECT

ACTION: Select mode for defining the lift distance.

RESULT 1: Prompt to key in lift distance appears (Result of choosing KEY IN OBJECT DISTANCES). (Go to Prompt 18.)

RESULT 2: Prompt to select lift distance from screen appears (Result of choosing SELECT LINE TO DEFINE OBJECT DISTANCES).

PROMPT 17: SELECT LINE TO DETERMINE DISTANCES OF OBJECT

ACTION: Select element from the screen which will represent the shelf onto which the object will be lifted

RESULT: Prompt to indicate center of plot for strength table appears. (Go to Prompt 22.)

PROMPT 18: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

ACTION: Key in value which represents the shelf height onto which the object will be lifted **<CR>**

RESULT: Prompt to key in distance object is in front of man-model appears.

PROMPT 19: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

ACTION: Key in value which represents the distance from the man-model to the front edge of the object **<CR>**.

RESULT: Prompt to indicate center of plot for strength table appears. (Go to Prompt 22.)

PROMPT 20: DEFINE FIRST ENDPOINT OF FIRST HANDLE

ACTION: Select an existing 3-D point to define End Point of handle or key in X,Y,Z coordinates of handle End Point **<CR>**

RESULT: Prompt to define second End Point of handle appears.

PROMPT 21: DEFINE SECOND ENDPOINT OF FIRST HANDLE

ACTION: Select an existing 3-D point to define coordinates of handle End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 22: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 23: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 24: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If lift is successful, man-model along with strength table appears on the drawing performing the lift; CADAM menu appears.

RESULT 2: If lift is unsuccessful because the distance from the man-model to the object is too great, then man-model appears on drawing attempting to perform lift; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the current posture is neither stand, sit, squat, kneeling on one knee, nor kneeling on two knees, then the LIFT Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR SELECTED POSTURE" appears.

RESULT 5: If the line segment selected to define the vertical and horizontal distances is parallel to the plane bisecting the man-model into two halves, then both distances remain undefined, the LIFT Task is abandoned and the message "LINE DEFINING DISTANCES DOES NOT CROSS MAN-MODEL PATH" appears.

RESULT 6: If the user picks a two hand lift with one handle, then the LIFT Task is abandoned and the message "LIFT WITH 1 HANDLE AVAILABLE FOR 1 ARM LIFT ONLY" appears.

RESULT 7: If the selected line defining the distances on the keyed distances for the LIFT task are definitely out of the man-model reach, then the LIFT Task is abandoned and the message "SELECTED LINE DEFINES DISTANCES TOO LARGE FOR REACH" appears.

PROMPT 25: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials Handling Tasks menu

RESULT: Materials Handling Tasks menu (Figure 3.24) appears.

8.2.2.4 Push

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **MATERIALS HANDLING icon**

RESULT: Materials Handling menu (Figure 3.24) appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **PUSH icon**

RESULT: New prompt appears.

PROMPT 4: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM PSHUSR EXECUTING appears and then the Mobility Selection menu (Figure 3.7) appears.

PROMPT 5: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Handle Selection menu (Figure 3.31) appears.

PROMPT 6: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select number of handles to be used

RESULT: Menu for selecting process to define object appears

PROMPT 7: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select process for defining object.

RESULT 1: Prompt to key in object height appears (Result of choosing KEY IN OBJECT DIMENSIONS). (Go to Prompt 12.)

RESULT 2: Prompt to select object height appears (Result of choosing SELECT OBJECT FROM SCREEN).

PROMPT 8: SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 9: SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 10: SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 11: SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT 1: Prompt to key in coefficient of friction appears (Result of selecting NO HANDLES). (Go to Prompt 23.)

RESULT 2: Prompt to define first endpoint of first handle appears (Result of selecting HANDLES). (Go to Prompt 19.)

PROMPT 12: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in value representing height of object **<CR>**

RESULT: Prompt to key in object width appears.

PROMPT 13: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 14: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in value representing depth of object **<CR>**

RESULT: Menu to select process for defining Push distances

PROMPT 15: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR OBJECT

ACTION: Select mode for defining Push distances

RESULT 1: Prompt to key in height object is from the support platform appears (Result of choosing KEY IN OBJECT DISTANCES). (Go to Prompt 17.)

RESULT 2: Prompt to select line to define object distances appears (Result of choosing SELECT LINE TO DEFINE OBJECT DISTANCES).

PROMPT 16: SELECT LINE TO DETERMINE DISTANCES FOR OBJECT

ACTION: Select element from screen which represents the shelf height where the object will be pushed

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 23.)

PROMPT 17: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

ACTION: Key in value which represents the shelf height where the object will be pushed **<CR>**

RESULT: Prompt to key in distance object is forward of man-model appears.

PROMPT 18: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

ACTION: Key in a value that represents the distance for the push. **<CR>**

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 23.)

PROMPT 19: DEFINE FIRST ENDPOINT OF FIRST HANDLE

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 1 or key in X,Y,Z coordinates of handle End Point 1 **<CR>**

RESULT: Prompt to define End Point 2 of right handle appears.

PROMPT 20: DEFINE SECOND ENDPOINT OF FIRST HANDLE

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT 1: Prompt to key in coefficient of friction appears. (Go to Prompt 23.)

RESULT 2: Prompt to define first endpoint of second handle appears (Result of choosing TWO HANDLES).

PROMPT 21: DEFINE FIRST ENDPOINT OF SECOND HANDLE

ACTION: Select an existing 3-D point to define coordinates of right handle of End Point 1 or key in X,Y,Z coordinates of left handle End Point 1 **<CR>**

RESULT: Prompt to define second End Point of second handle appears.

PROMPT 22: DEFINE SECOND ENDPOINT OF SECOND HANDLE

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to key in coefficient of friction appears.

PROMPT 23: KEY IN COEFFICIENT OF FRICTION

ACTION: Key in value to define coefficient of friction between man-model's shoes and the surface on which he is standing **<CR>**

RESULT: Menu to determine object clearance appears.

PROMPT 24: SELECT MENU WHICH IDENTIFIES THE NEED FOR OBJECT CLEARANCE

ACTION: Select type of object clearance from bottom menu

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 25: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 26: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display type menu appears.

PROMPT 27: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If push is successful, the man-model and strength table appear on the drawing performing the push; CADAM menu appears.

RESULT 2: If push is unsuccessful because the distance from the man-model to the object is too great, then the man-model appears on drawing attempting to perform push; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the selected posture does not relate to the current strength data, the push task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR SELECTED POSTURE" appears.

Presently only the stand and sit postures have strength data.

RESULT 5: If a line segment chosen for defining the push distance runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; consequently the push distance remains undefined and the "LINE DEFINING DISTANCES DOES NOT CROSS THE MAN-MODEL PATH" appears.

RESULT 6: If the coefficient of friction entered is less than 0.00001, then the coefficient of friction remains undefined and the message "INVALID COEFFICIENT OF FRICTION -- < 0.00001" appears.

RESULT 7: If the selected handle endpoints are the same, then the PUSH Task is abandoned and the message "INVALID HANDLES -- ENDPOINTS ARE THE SAME" appears.

RESULT 8: If any one of the object dimensions input is less than one inch, then the PUSH Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR OBJECT DIMENSIONS DEFINED" appears.

RESULT 9: If the user has selected a push distance that is impossible for the man-model to reach, the PUSH Task is abandoned and the message "SELECTED LINE DEFINES DISTANCES TOO LARGE FOR REACH" appears.

PROMPT 28: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials Handling menu

RESULT: Materials Handling menu (Figure 3.24) appears.

8.2.2.5 Pull

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **MATERIALS HANDLING icon**

RESULT: Materials Handling menu (Figure 3.24) appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **PULL icon**

RESULT: New prompt appears.

PROMPT 4: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM PLLUSR EXECUTING appears and then the Mobility Selection menu (Figure 3.7) appears.

PROMPT 5: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Handle Selection menu (Figure 3.33) appears.

PROMPT 6: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select handle type to be used

RESULT: Menu for selecting process to define object appears.

PROMPT 7: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select mode for defining object dimensions

RESULT: Prompt to key in object height appears (Result of choosing KEY IN OBJECT DIMENSIONS). (Go to Prompt 18.)

RESULT: Prompt to select object height appears (Result of choosing SELECT OBJECT FROM SCREEN).

PROMPT 8: SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 9: SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 10: SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 11: SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT: Prompt to define first endpoint of a handle appears.

PROMPT 12: DEFINE FIRST ENDPOINT OF FIRST HANDLE

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 1 or key in X,Y,Z coordinates of handle End Point 1 **<CR>**

RESULT: Prompt to define second endpoint of handle appears.

PROMPT 13: DEFINE SECOND ENDPOINT OF FIRST HANDLE

ACTION: Select an existing 3-D point to fine coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT 1: Prompt to key in coefficient of friction appears. (Go to Prompt 23.)

RESULT 2: Prompt to define first endpoint of second handle appears (Result of choosing TWO HANDLES).

PROMPT 14: DEFINE FIRST ENDPOINT OF SECOND HANDLE

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 1 or key in X,Y,Z coordinates of handle End Point 1 **<CR>**

RESULT: Prompt to define second End Point of handle appears.

PROMPT 15: DEFINE SECOND ENDPOINT OF SECOND HANDLE

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to key in coefficient of friction appears (Go to Prompt 23).

PROMPT 16: KEY IN HEIGHT DIMENSION OF OBJECT

ACTION: Key in value which represents the height of the object **<CR>**

RESULT: Menu to select mode for object dimensions appears.

PROMPT 17: KEY IN WIDTH DIMENSION OF OBJECT

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 18: KEY IN DEPTH DIMENSION OF OBJECT

ACTION: Key in value representing depth of object **<CR>**

RESULT: Menu to select process to define pull distances appears.

PROMPT 19: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR OBJECT

ACTION: Select process to define pull distances.

RESULT 1: Prompt to key in vertical distance for pull appears (Result of choosing KEY IN OBJECT DISTANCES). (Go to Prompt 21.)

RESULT 2: Prompt to select shelf to define pull distance appears (Result of choosing SELECT LINE TO DEFINE OBJECT DISTANCES).

PROMPT 20: SELECT LINE TO DEFINE OBJECT DISTANCES

ACTION: Select element from screen which represents the shelf height where the object will be pulled

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 23.)

PROMPT 21: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

ACTION: Key in value which represents the shelf height where the object will be pulled **<CR>**

RESULT: Prompt to key in distance object is in front of man-model

PROMPT 22: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

ACTION: Key in a value that represents the distance for the pull. **<CR>**

RESULT: Prompt to key in coefficient of friction appears.

PROMPT 23: KEY IN COEFFICIENT OF FRICTION

ACTION: Key in value to define coefficient of friction between man-model's shoes and the surface on which he is standing <CR>

RESULT: Menu to determine object clearance appears.

PROMPT 24: SELECT MENU WHICH IDENTIFIES THE NEED FOR OBJECT CLEARANCE

ACTION: Select type of object clearance

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 25: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 26: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display type menu appears.

PROMPT 27: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If pull is successful, the man-model and strength table appear on the drawing performing the pull; CADAM menu appears.

RESULT 2: If pull is unsuccessful because the distance from the man-model to the object is too great, then the man-model appears on drawing

attempting to perform pull; missed distance appears on screen; CADAM menu appears.

RESULT 3: If pull is unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the selected posture does not relate to the current strength data, the PULL Task is abandoned and the message "NO STRENGTH DATA

AVAILABLE FOR SELECTED POSTURE" appears. Presently only the stand and sit postures have strength data.

RESULT 5: If a line segment chosen for defining the pull distance runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; consequently the pull distance remains undefined and the "LINE DEFINING DISTANCES DOES NOT CROSS THE MAN-MODEL PATH" appears.

RESULT 6: If the coefficient of friction entered is less than 0.00001, then the coefficient of friction remains undefined and the message "INVALID COEFFICIENT OF FRICTION -- < 0.00001" appears.

RESULT 7: If the selected handle endpoints are the same, then the PULL Task is abandoned and the message "INVALID HANDLES -- ENDPOINTS ARE THE SAME" appears.

RESULT 8: If any one of the object dimensions input is less than one inch, then the PULL Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR OBJECT DIMENSIONS DEFINED" appears.

RESULT 9: If the user has selected a push distance that is impossible for the man-model to reach, the PULL Task is abandoned and the message "SELECTED LINE DEFINES DISTANCES TOO LARGE FOR REACH" appears.

PROMPT 28: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials Handling menu

RESULT: Materials Handling menu (Figure 3.22) appears.

8.2.2.6 Reach

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **MATERIALS HANDLING icon**

RESULT: Materials Handling menu (Figure 3.24) appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **REACH icon**

RESULT: New prompt appears.

PROMPT 4: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM REAUSR EXECUTING appears and then the Arm Selection menu (Figure 3.35) appears.

PROMPT 5: SELECT ARM TO BE USED DURING TASK

ACTION: Select which arm will perform the reach

RESULT: Mobility Selection menu (Figure 3.7) appears.

PROMPT 6: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Grip Type Selection menu for Reach (Figure 3.36) appears.

PROMPT 7: SELECT REACH EXTENT TO BE USED DURING THE TASK

ACTION: Select the grip to be used in the task

RESULT 1: Prompt to select reach point for right hand appears (Result of selecting RIGHT or BOTH ARMS)

RESULT 2: Prompt to select reach point for left hand appears (Result of selecting LEFT ARM)

PROMPT 8: DEFINE REACH POINT FOR RIGHT ARM

ACTION: Select an existing 3-D point from the screen to define Reach Point or key in the X,Y,Z coordinates of Reach Point **<CR>**

RESULT 1: Obstacle Avoidance Selection menu appears. (Go to Prompt 10.)

RESULT 2: Prompt to define reach point for left arm appears (Result of choosing BOTH ARMS).

PROMPT 9: DEFINE REACH POINT FOR LEFT ARM

ACTION: Select an existing 3-D point from the screen to define Reach Point for Left Arm or key in the X,Y,Z coordinates of Left Arm Reach Point **<CR>**

RESULT: Obstacle Avoidance Selection menu appears

PROMPT 10: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display type menu appears.

PROMPT 11: SELECT DESIRED DISPLAY TYPE

ACTION: Select display type (See Table 2.1)

RESULT 1: If reach is successful, man-model appears on drawing performing Reach; CADAM menu appears.

RESULT 2: If reach is unsuccessful because the distance from the man-model to the reach point is too great, the man-model appears on the drawing attempting to perform the reach; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If a two hand reach was chosen and both reach points are the same, then the REACH Task is abandoned and the message "-- **ERROR** CANNOT REACH WITH 2 HANDS TO ONE POINT" appears.

PROMPT 12: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials Handling menu

RESULT: Materials Handling menu (Figure 3.22) appears.

8.2.3 Connector Analysis Function

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **CONNECTOR icon**

RESULT: New prompt appears

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM CTRUSR EXECUTING appears and then the Grip Selection menu (Figure 3.38) appears.

PROMPT 4: SELECT GRIP TO BE USED DURING TASK

ACTION: Select the grip type to be used

RESULT: Connector Size menu (Figure 3.39) appears.

PROMPT 5: SELECT CONNECTOR SIZE TO BE USED DURING TASK

ACTION: Select the connector size to be used

RESULT: Prompt to define head point of attachment appears.

PROMPT 6: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point which defines the point at which the man-model grips the connector or key in X,Y,Z coordinates to define the point at which the man-model grips the connector **<CR>**

RESULT: Prompt to define tail point of attachment appears.

PROMPT 7: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point which defines the direction at which the man-model will reach the connector or key in X,Y,Z coordinates to define the direction at which the man-model will reach the connector **<CR>**

RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 8: SELECT HAND TO BE USED DURING TASK

ACTION: Select hand will reach for the connector

RESULT: Mobility Type Selection menu (Figure 3.7) appears.

PROMPT 9: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select the mobility type to use during the Reach analysis

RESULT: Prompt to define Center of Strength table appears.

PROMPT 10: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a 2-D point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 11: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display Type menu appears.

PROMPT 12: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If task is successful, the man-model and strength table appear on the drawing performing a task; CADAM menu appears.

RESULT 2: If task is unsuccessful because the distance from the man-model to the connector is too great, the man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 13: SEL MENU

ACTION: Select **/RECOVER/** to continue any analysis

RESULT: Task Analysis menu (Figure 3.1) appears.

8.3 VISIBILITY ANALYSIS FUNCTION

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **VISIBILITY icon**

RESULT: New prompt appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM VISUSR EXECUTING appears and then the menu to select viewpoint as seen by man-model or as user-defined arbitrary point.

PROMPT 3: SELECT VIEWPOINT OPTION

ACTION 1: Select **CREWCHIEF'S** to see the work place from the man-model's viewpoint

RESULT: Menu to include or exclude man-model appears

ACTION 2: Select **USER DEFINED** to define viewpoint

RESULT: Prompt to define eye location point appears (Go to Prompt 5.)

PROMPT 4: SELECT INCLUDE/EXCLUDE MAN-MODEL OPTION

ACTION: Select from menu whether to include or exclude the man-model during visual analysis

RESULT: Prompt to define center of visibility plot appears. (Go to Prompt 7.)

PROMPT 5: DEFINE EYE LOCATION POINT

ACTION: Select an existing 3-D point to define the eye location or key in the X,Y,Z coordinates to define the eye location point **<CR>**

RESULT: Prompt to define eye target point appears.

PROMPT 6: DEFINE EYE TARGET POINT

ACTION: Select an existing 3-D point to define the eye target point or key in the X,Y,Z coordinates to define the eye target point **<CR>**

RESULT: Prompt to define center of visibility plot appears.

PROMPT 7: DEFINE CENTER OF PLOT

ACTION: Indicate a 2-D point to determine where the center of visibility plot will appear on screen

RESULT: Plot appears on screen as specified by center of plot location.

PROMPT 8: SEL MENU

ACTION: Select **/RECOVER/** to continue any analysis

RESULT: CREW CHIEF Main Programs menu (Figure 1.3) appears.

8.4 ACCESSIBILITY ANALYSES FUNCTION

8.4.1 CREW CHIEF Interference Analysis Function

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **ACCESSIBILITY icon**

RESULT: CREW CHIEF Accessibility Analyses menu (Figure 5.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **INTERFERENCE icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM ITFUSR EXECUTING appears and then the Level of Interference Checking menu (Figure 5.2) appears.

PROMPT 4: SELECT LEVEL OF INTERFERENCE TO BE CHECKED

ACTION: Select the level of interference to be used in the analysis

RESULT: Display type menu appears.

PROMPT 5: SELECT DESIRED DISPLAY TYPE

ACTION: Select a display type (see Table 2.1)

RESULT: Man-model appears superimposed on drawing and, if interference found, 3-D arrows indicating points of interference between the man-model and elements in the drawing are displayed.

PROMPT 6: SEL MENU

ACTION: Select **/RECOVER/** to return to the CREW CHIEF Accessibility Functions menu (Figure 5.1)

RESULT: Program returns to the CREW CHIEF Accessibility Functions menu (Figure 5.1).

8.4.2 <u>Work Envelope Analysis Function</u>

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **ACCESSIBILITY icon**

RESULT: CREW CHIEF Accessibility Analyses menu (Figure 5.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **WORK ENVELOPE icon**

RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM WRKUSR EXECUTING appears and then the types of Work Envelope menu (Figure 5.4) appears.

PROMPT 4: SELECT WORK ENVELOPE TO BE OUTPUT

ACTION 1: Select **FULL SWEPT** to determine full sweep of tool handle

RESULT: The tool appears in the drawing attached as it was in the previous tool analysis. The full sweep of the tool handle is displayed (END OF WORK ENVELOPE).

ACTION 2: Select **TOOL ENVELOPE** to determine obstructed sweep of handle

RESULT: Prompt to key in increment for tool envelope appears.

ACTION 3: Select **WORK ENVELOPE** to determine obstructed sweep of handle with reach limits

RESULT: Prompt to key in Work E velope reach increment appears. (Go to Prompt 6).

PROMPT 5: KEY IN INCREMENT FOR TOOL ENVELOPE, MUST >0

ACTION: Key in the tool envelope increment **<CR>** or accept the default.

RESULT: The tool appears in the drawing with the tool attached as it was in the previous tool analysis. The sweep of the tool handle, as obstacles will allow, is displayed on the screen (END OF WORK ENVELOPE).

PROMPT 6: KEY IN WORK ENVELOPE REACH INCREMENT TO BE USED FOR ANALYSIS

ACTION: Key in the reach increment **<CR>** or accept the default value

RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 7: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types

RESULT: Display Type menu appears.

PROMPT 8: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT: The man-model appears in the drawing with the tool attached as it was in the previous tool analysis. The sweep of the tool handle, as reach and obstacles will allow, is displayed on the screen.

PROMPT 9: SEL MENU

ACTION: Select **/RECOVER/** to return to the Accessibility Analysis menu

RESULT: Accessibility Analysis menu (Figure 5.1) appears.

8.5 DISPLAY CURRENT CREW CHIEF DATA FUNCTION

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **CONFIGURATION icon**

RESULT: New prompt appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM CFGUSR EXECUTING appears and then Prompt to define center of plot appears.

PROMPT 3: DEFINE CENTER OF DATA SHEET

ACTION: Indicate a point on the screen to determine where the center of the CREW CHIEF data sheet will appear

RESULT: The current CREW CHIEF data sheet appears on the screen.

PROMPT 4: SEL MENU

ACTION: Select **/RECOVER/** to return to the CREW CHIEF Main Programs menu (Figure 1.3)

RESULT: Program returns to the CREW CHIEF Main Programs menu (Figure 1.3).

REFERENCES

1. CADAM Geometry Interface Installation Guide, #C-200-050-I, Burbank, CA: CADAM, Inc., 1 Dec 1984.

2. CADAM Interactive User Reference Manual (Vol. 2), #C-200-020-URM, Burbank, CA: CADAM, Inc., 1 Dec 1984.

3. Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

4. Ayoub, M.M., Denardo, J.D., Smith, J.L., Bethea, N.J., Lambert, B.K., Alley, L.R., & Duran, B.S., Establishing Physical Criteria for Assigning Personnel to Air Force Jobs, Lubbock, TX: Institute for Ergonomic Research, Texas Tech University, Sept 1982.

5. CADAM Geometry Interface, User Reference Manual, #C-200-050-5, Burbank, CA: CADAM, Inc., 16 Aug 1984.

APPENDIX A

GENERATION OF THE PHYSICAL CHARACTERISTICS AND CAPABILITIES OF THE MAN-MODEL

APPENDIX A

GENERATION OF THE PHYSICAL CHARACTERISTICS AND CAPABILITIES OF THE MAN-MODEL

The primary purpose of the CREW CHIEF system of programs is to improve maintainability during the design process by assessing the interactions of the physical characteristics and capabilities of the maintenance technician and the work station. MIL-STD-1472C, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities," (Reference A.1), and changes thereto, establishes general human engineering criteria for military systems, subsystems, equipment, and facilities.

Paragraph 5.6.1 states: "Generally, design limits shall be based upon a range from the 5th percentile female to the 95th percentile male values for critical body dimensions, as appropriate. For any body dimension, the 5th percentile value indicates that five percent of the population will be equal to or smaller than that value, and 95 percent will be larger; conversely, the 95th percent value indicates that 95 percent of the population will be equal to or smaller than that value, and five percent will be larger. Therefore, use of a design range from the 5th to 95th percentile will theoretically provide coverage for 90 percent of the user population for that value."

Paragraph 5.6.3.2 states: "Clearance dimensions (e.g., for passageways and access), which must accommodate or allow passage of the body, or parts of the body, shall be based upon the 95th percentile values for body dimensions."

Paragraph 5.6.3.3 states: "Limiting dimensions (reaching distance, control movement, displays, test points, handrails, etc.) which restrict, or are limited by, extensions of the body shall be based upon the 5th percentile values for applicable body dimensions."

The CREW CHIEF programs must work within the design criteria stated here. Thus the range of operator sizes must necessarily include, as a minimum, the range of 5th percentile female through 95th percentile male. The program includes the 1st, 5th, 50th, 95th, and 99th percentile body sizes for both male and female; thus there is a range of 1st percentile female through 99th percentile male. Pending changes to Military Standards and Specifications are expected to require this range in some applications. This appendix addresses the body size of the technician model as a function of the skeletal link system, enfleshment, and clothing bulk.

Since maintenance technicians work in a wide range of postures, the joint mobility of the skeletal link system is a vital consideration to the development of the model. Additionally, the effect of body/body segment mass and center of gravity must be considered in establishing joint mobility limits. A maintenance technician must be able to maintain balance while performing a task. Thus, individual joint mobility limits may vary with differing body segment relationships for changes in posture.

The ability of the technician to see the task object is another area of concern. This appendix also addresses the data bases and derivation of the visual analysis function of the programs.

The ability to apply force in a specific manner to a task-related object is another physical capability that is addressed in the CREW CHIEF programs. The development of the strength data bases will also be discussed.

A.1 CREW CHIEF MODEL SKELETAL LINK SYSTEM AND ENFLESHMENT

The model used in the CREW CHIEF system of programs is based on a 36-link skeletal system. These links connect the major points of rotation of body segments and are used to

graphically display the model in different postures. The lengths of the links are calculated by regression from 13 readily measured anthropometric variables (e.g., stature, sitting height, weight, etc.).

The 1965 Survey of US Air Force Male Personnel (Reference A.2) was used as the basis for the male calculations. This survey includes 3869 subjects. Officer subjects were discarded, as were those subjects not meeting current weight restrictions of Air Force Regulation (AFR) 160-43. The remaining 2084 subjects were used for the regression equation data pool.

The 1968 Survey of US Air Force Women (Reference A.3) and the 1977 Survey of US Army Women (Reference A.4) were purged of data of subjects not meeting the weight limits of AFR 160-43. The remaining 3037 subjects from the two surveys were used for the regression equation data pool for females.

The 1981 Study of Weight Lifting Capabilities of Air Force Basic Trainees (Reference A.5) was selected as the best reflection of the current Air Force maintenance technician population. This survey had only two relevant anthropometric measures, stature and weight. The regression equations calculated from the 1965 US Air Force Male Personnel, 1968 US Air Force Women, and 1977 US Army Women surveys were applied to the variables (stature and weight) from the 1981 survey of Air Force Basic Trainees to calculate the remaining 11 anthropometric variables required to generate the 36 internal links and the enfleshment of the CREW CHIEF man-model.

The enfleshment of the CREW CHIEF man-model is based on a modeling technique to define three-dimensional (3-D) coordinates of solid objects. Solid objects, such as hand forms, head forms, and boots, are divided into triangular facets with the vertices and edges of the triangles identified for tracking. A sonic digitizer is used to define the local X, Y, and Z coordinates of the vertices. A series of sorting routines to identify

coincidental edges and points; to convert local X,Y,Z coordinates to the CREW CHIEF coordinate system; and to determine the display lines are used to provide the desired graphic presentation.

Ellipses are placed about major joint centers. The ellipses are connected, and the modeling technique for solid objects is used to determine the display lines for the body enfleshment. Multiple ellipses are placed at the joint centers, e.g., the knees, elbows, and shoulders, which exhibit high compressibility. The body is divided into 13 semi-unique sets of ellipses. These are the lower and upper trunk, head, lower and upper arms (left and right), hands (left and right), and lower and upper legs (left and right), with the lower legs including the feet. These sets are classified as semi-unique in that a main ellipse may be contained in different sets. For example, the lower and upper arm sets each contain the main ellipse at the elbow.

To increment the nude enfleshment radii to portray clothing bulk, subjects were measured both nude and in the four clothing configurations (fatigues, fatigues with jacket, arctic, and chemical defense).

A.2 CREW CHIEF MODEL JOINT MOBILITY

Joint mobility is the movement at the skeletal links which defines and portrays the various postures of the technician model. Posture includes the variations in positioning of body segments, such as arms, legs, and trunk segments, to properly position the technician model in relation to the task object. Two aspects must be considered: first, the limits of motion (joint mobility limits) around an individual joint; and second, the stability (balance) of the technician model when in a specific posture in relation to the task object.

Joint mobility limits are based, at present, upon previous range of motion studies. The mobility limits data are being

updated as a result of recent research and will be included in future CREW CHIEF releases. Future mobility limits will also address out-of-balance conditions.

A.3 CREW CHIEF MODEL VISUAL ANALYSIS

The techniques for displaying the field-of-view of the technician model are relatively simple and already exist. Existing vision data bases are primarily concerned with peripheral vision. A maintenance technician man-model must be concerned with visual acuity rather than with peripheral vision. Data bases for visual acuity (field-of-focus) must be generated. Planning to collect the data for these data bases is in progress.

A.4 CREW CHIEF MODEL STRENGTH CAPABILITIES

The strength capabilities of the CREW CHIEF man-model are divided into two areas.

(1) Torque: the ability to apply a force to:

(a) a tool, primarily a wrench, that results in a torque value that can be applied to a fastener. See Appendix C for those tools which will have torque values in the program.

(b) an electrical connector, with the hand alone, in a clockwise or counter-clockwise direction.

(2) Materials Handling: related to moving, lifting, carrying, pushing, pulling, positioning, and holding objects.

Strength, in general, is not highly correlated to body size. Thus, in the CREW CHIEF man-model, the percentile values are based on strength capabilities across a population, not on the percentile value of the body size. Strength data bases for CREW CHIEF were created from ergonomics studies specifically

designed to simulate aircraft maintenance tasks. Strength data from test subjects were related to the aircraft technician population through a series of strength tests that had been previously administered to Air Force personnel. Since there are few restrictions on the assignment of Air Force personnel to maintenance AFSCs, these subjects were deemed to be representative of the Air Force maintenance technician population. During the data collection phase of Torque and Materials Handling data bases, subjects performed 1 to 7 of the same strength tests. Regressors from the cited study are used to distribute the predictions from the Torque and Materials Handling data bases across the maintenance population.

A.4.1 TORQUE

Data bases providing the information required to predict the force a maintenance technician can exert on a wrench, or electrical connector, were not available when CREW CHIEF program development was begun. A series of tests using torque measuring devices was implemented. The basic variables in the wrench torque studies include posture; bolt elevation as a percentage of the finger tip vertical reach for a given posture; distance of the body from the bolt head; wrench handle orientation (selected position around the 360-degree circle of the bolt axis); bolt orientation (relative to the mid-sagittal plane of the body); type wrench (ratchet with socket, open end, box end, etc.); and the reach around and over obstacles to the wrench handle.

Experiments were performed to develop the data bases for the prediction of force that can be applied to an electrical connector. The variables considered in the electrical connector experiments were: connector diameter (three sizes); type of grip (two types); hand covering (bare and two types of glove); direction of torque (clockwise and counter-clockwise); work height (as a percentage of subject's finger tip vertical reach);

direction of approach (front, back and side); and distance of connector from other connectors above, below, or to the side of the task connector.

A.4.2 MATERIALS HANDLING

A series of experiments is being conducted to develop the Materials Handling data bases. The lifting phases of the experiments are done in various postures (kneeling, standing, sitting, supine and prone). Lifting tasks are one- or two-handed. Various size boxes are used for the different tasks, and the weight can be adjusted. The subject could request the experimenter to add or remove weight until the subject reached his maximum without straining himself. (The weights were not individually marked, so the subject did not know the weight lifted.)

A common task in system maintenance is to position an object and hold it in place with one hand while securing it with the other hand. Hold/Position studies are based on posture, target height (expressed as a percentage of the subject's finger-tip vertical reach for the posture used in the exertion), barriers (used above and in front of the target to simulate working conditions), and the weight of the object (variable from 10 to 110 pounds). The object is positioned with both hands and, once positioned, is held in place with the left hand. The time the object is held within the confines of the target is measured up to a maximum of 60 seconds. Sixty subjects, 30 female and 30 male, participated in the experiment.

Experiments were performed to collect data for Push/Pull capabilities. This study was divided into three phases, with a total of 230 exertions performed by 20 female and 20 male subjects. Subjects were selected on the basis of age (18 to 30 years), body size and weight limits within the limits of AFR 160-43, and their abilities to lift 40 pounds to 6 feet on a weight lift machine (attainment of a Factor-X Score of 3).

Variables for the exertions included five postures, two directions (push and pull), handle position (distance above the support platform), foot position (distance from the handle expressed as percentage of vertical reach), and angle of the elbow (straight or bent). Exertions were also performed in two methods (freestyle and controlled). In freestyle, the subject was allowed to push or pull to attain the maximum horizontal force. In controlled, the subject was required to keep the vertical force less than 10% of the maximum horizontal force. A sonic digitizer was used to digitize 14 points on the body during each exertion and to relate body angles to force data.

APPENDIX B

CLOTHING ENSEMBLE DESCRIPTIONS

APPENDIX B
CLOTHING ENSEMBLE DESCRIPTIONS

B.1 FATIGUES, WITHOUT JACKET

The fatigues ensemble (see Figure B.1) is the normal work clothing for maintenance technicians and is worn in shops and on the flight line during moderate to hot temperatures. The shirt has long or short sleeves. The shoes are rubber-soled work shoes or flight boots. The fatigue cap is part of the ensemble, but is often removed during maintenance activities.

B.2 FATIGUES, WITH JACKET

This uniform consists of the basic fatigues ensemble with a jacket added. It is used at cooler temperatures on the flight line and in unheated shops (see Figure B.2).

B.3 ARCTIC

The arctic clothing ensemble adds a parka with fur-lined hood, insulated trousers, and mittens to the fatigue ensemble for protection in cold temperatures. The mukluk replaces the work shoes or flight boots. Under wet conditions, the work shoes or flight boots may be worn, because the mukluks are not water-resistant. Due to their inhibition of manual dexterity, the mittens are normally replaced with the work glove while performing maintenance, so they are not included in the graphic display of the technician model. The parka hood over the head can restrict the technician's vision. During maintenance activities, if the hood interferes with the technician's vision, it is laid back on the shoulders (see Figure B.3).

Figure B.1. Photograph Showing Fatigues Ensemble:
(a) Side View, and (b) Front View.

Figure B.2. Photograph Showing Fatigues Ensemble With Jacket Added: (a) Side View, and (b) Front View.

Figure B.3. Photograph of Man Wearing Arctic Clothing Ensemble: (a) Side View, and (b) Front View.

B.4 CHEMICAL DEFENSE

The chemical defense ensemble (see Figure B.4) is worn over fatigues and consists of a mask, over-garment, hood, over-boots, and rubber gloves. Both cotton and rubber gloves are worn under the leather work gloves. This ensemble is used when the technician is threatened with hazardous chemical/biological agents.

Figures B.5 through B.8 show the man-model as it appears in each of these clothing ensembles. Default clothing type is fatigues (Figure B.5).

Figure B.4. Photograph of Man Wearing Chemical Defense Ensemble: (a) Right View, (b) Front View, and (c) Left View.

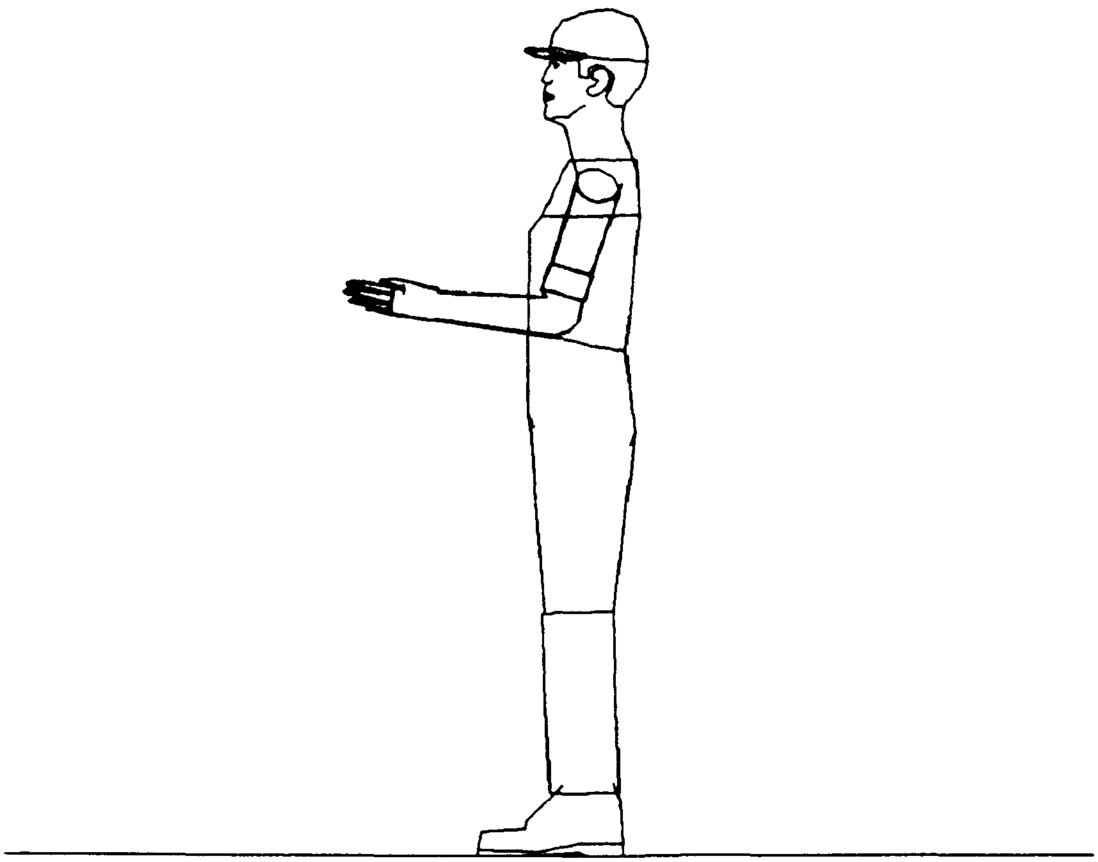


Figure B.5. Fatigues, Without Jacket.

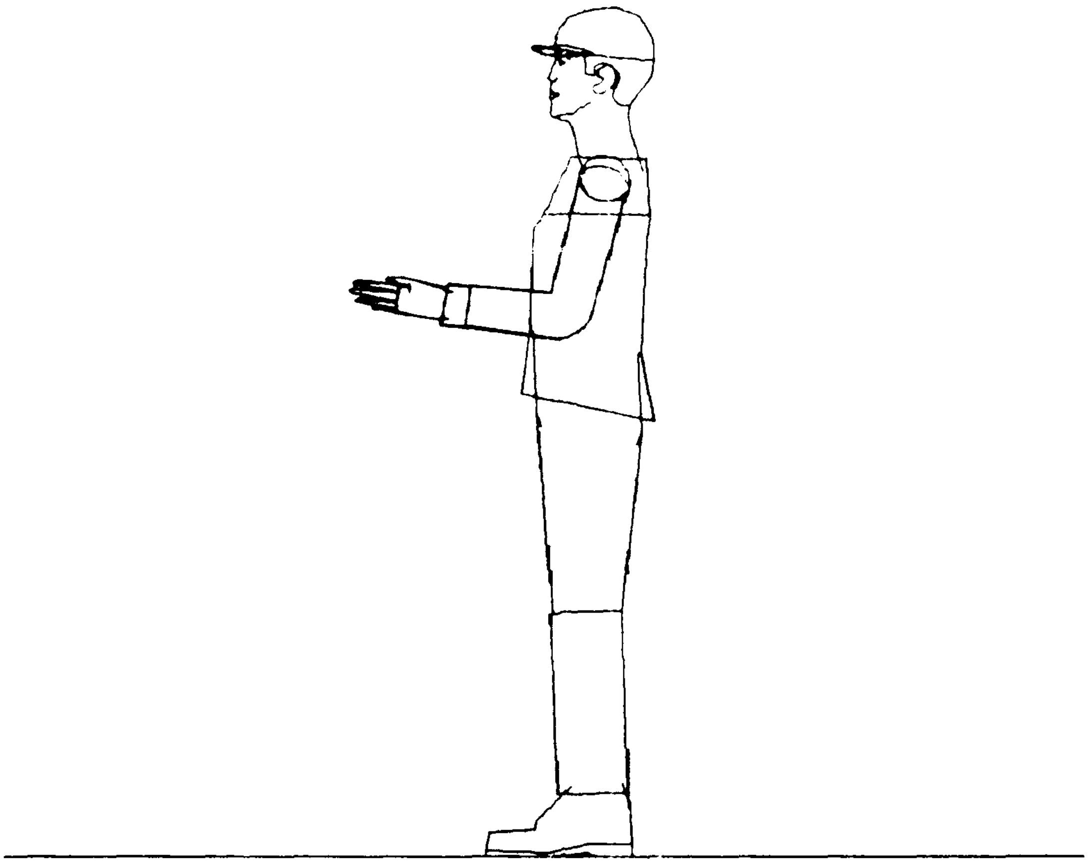


Figure B.6. Fatigues, With Jacket.

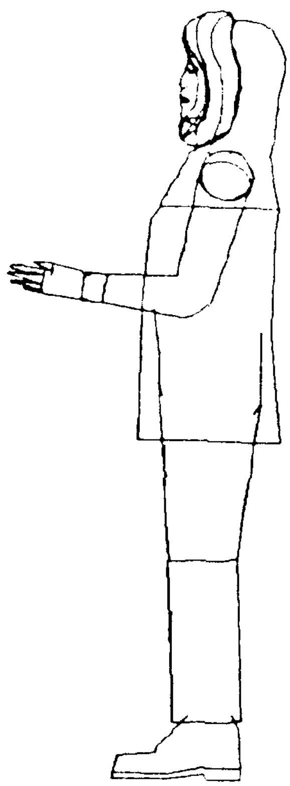


Figure B.7. Arctic Ensemble.

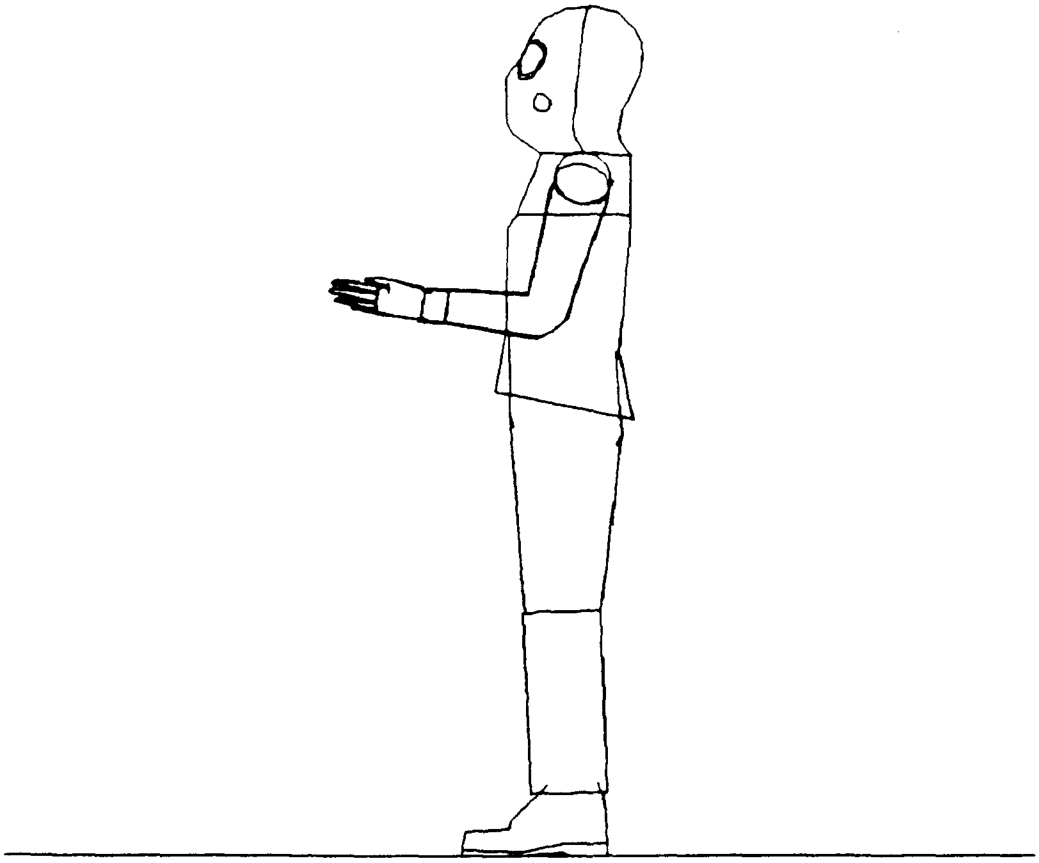


Figure B.8. Chemical Defense Ensemble.

APPENDIX C

BODY POSTURES

APPENDIX C
BODY POSTURES

The twelve postures represent common postures found in a maintenance environment. These postures allow initial generation of the man-model in a posture which closely approximates the one desired. The initial postures can be further modified manually (using the Reposition Function), or automatically by the Task Analysis functions. The twelve postures available in the Initialization Function can be seen in Figures C.1 through C.12. Standing posture is the default.

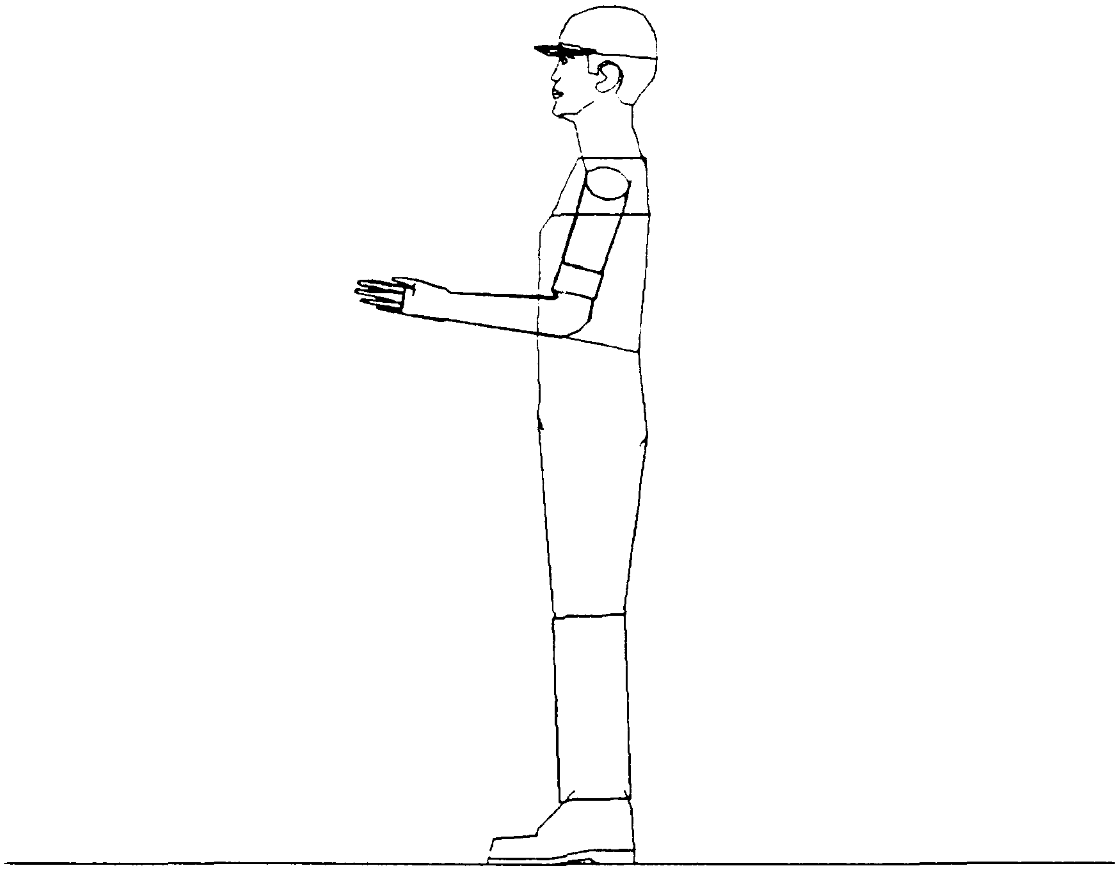


Figure C.1. Initial Stand Posture, with Position Reference Point on Platform and Centered Between the Ankles.

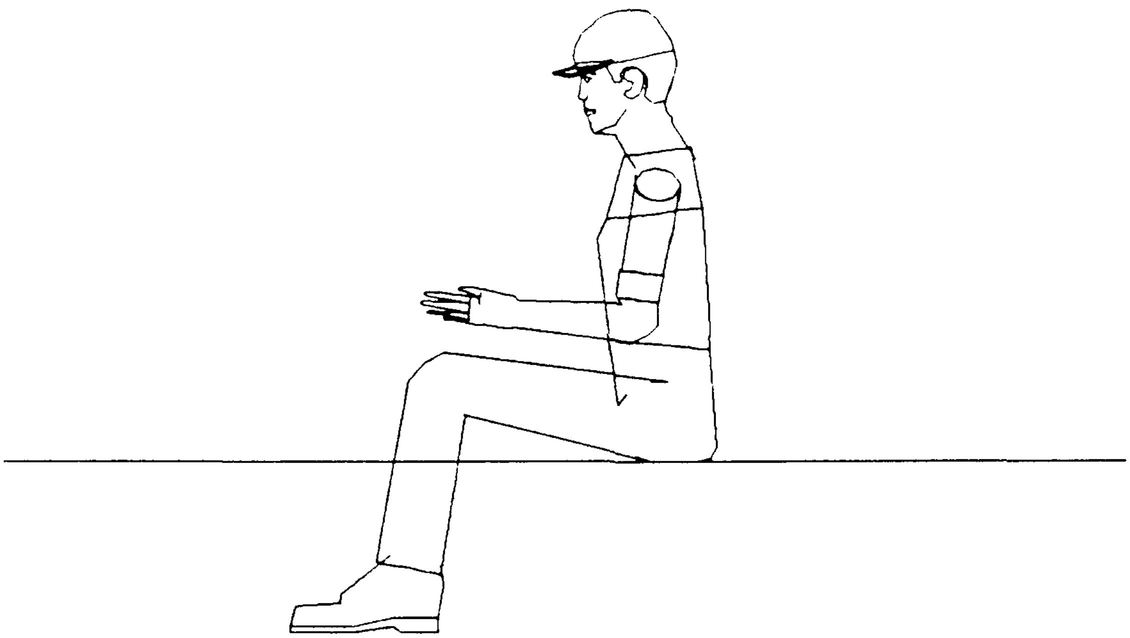


Figure C.2. Initial Sitting Posture, with Position Reference Point at Center of Seat Pan.

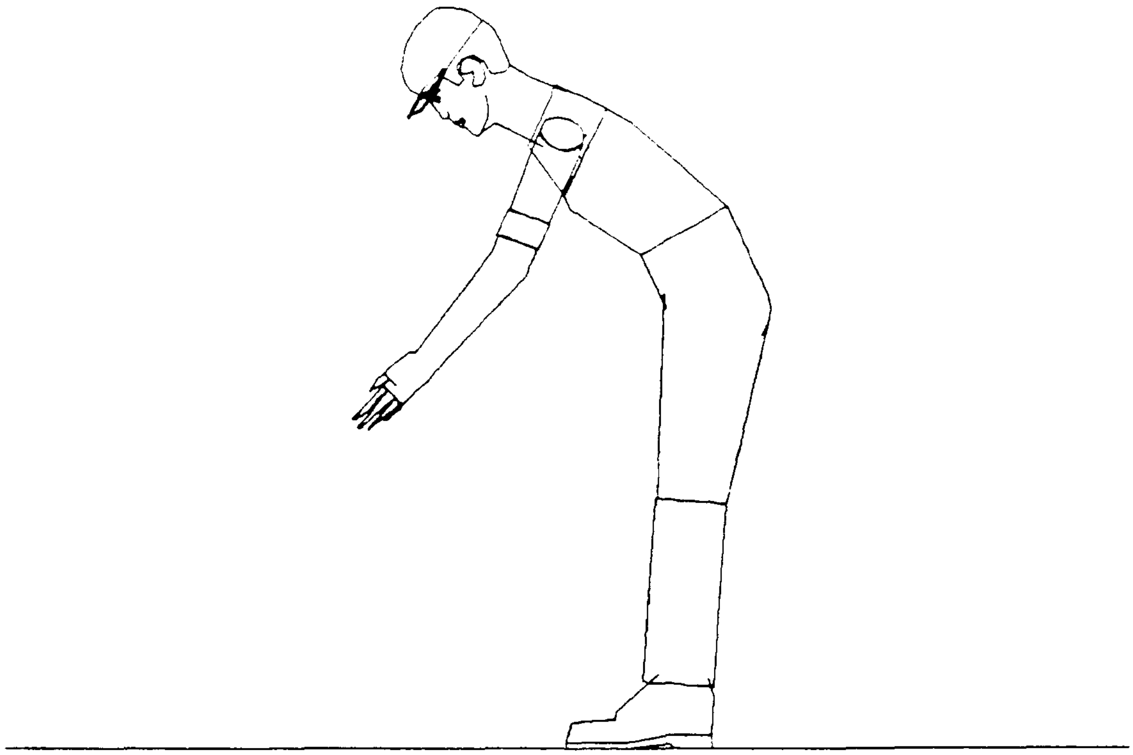


Figure C.3. Initial Bend Posture, with Position Reference Point on Platform and Centered Between the Ankles.

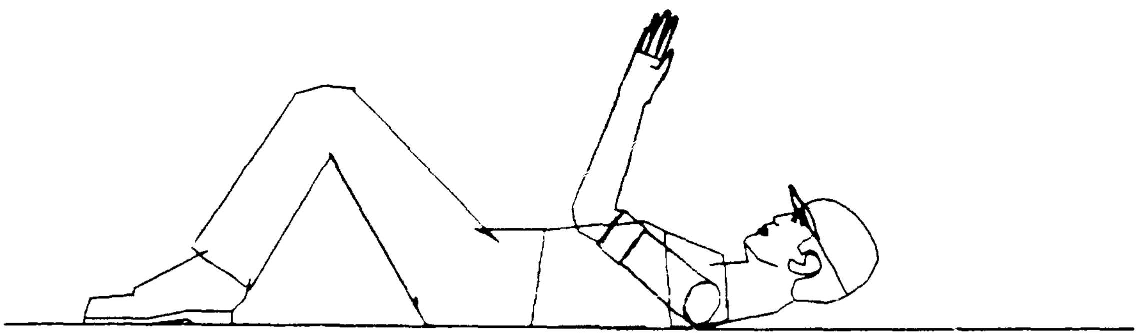


Figure C.4. Initial Supine Posture, with Position Reference Point on Platform and Centered Between Shoulders.

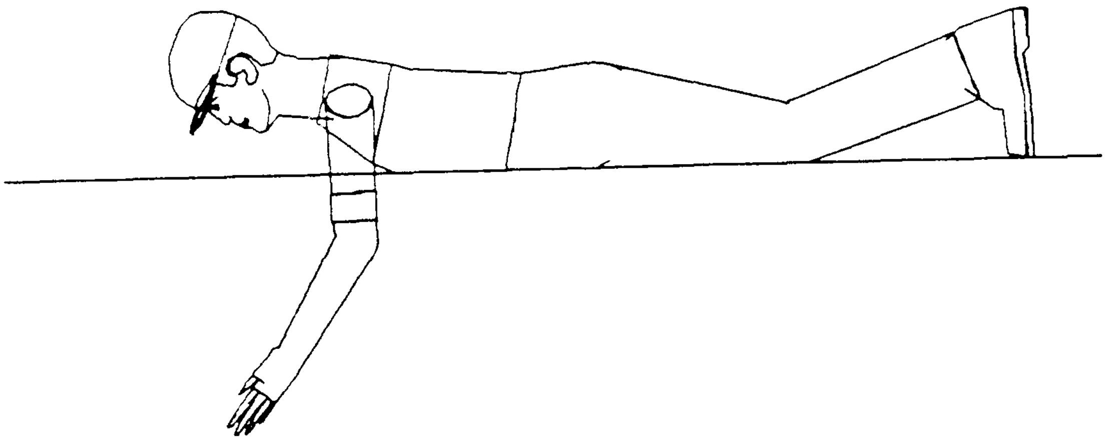


Figure C.5. Initial Prone Posture, with Position Reference Point on Platform and Centered Between Shoulders.

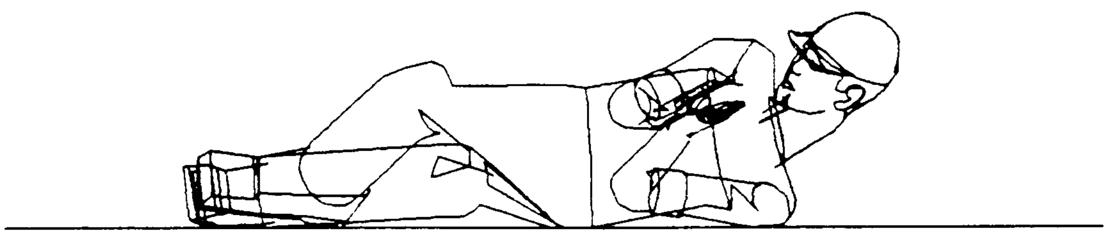


Figure C.6. Initial Side Posture, with Position Reference Point on Platform and Centered Between Shoulders.

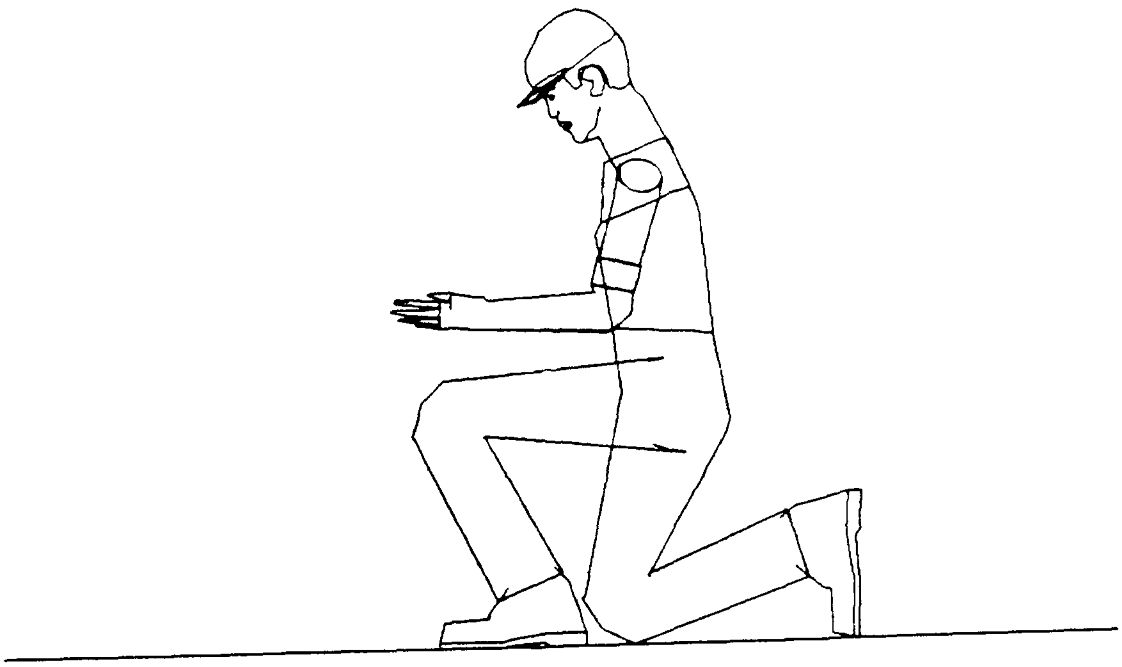


Figure C.7. Initial Kneel Posture, One Knee, with Position Reference Point on Platform and Centered Between Left Knee and Right Foot.

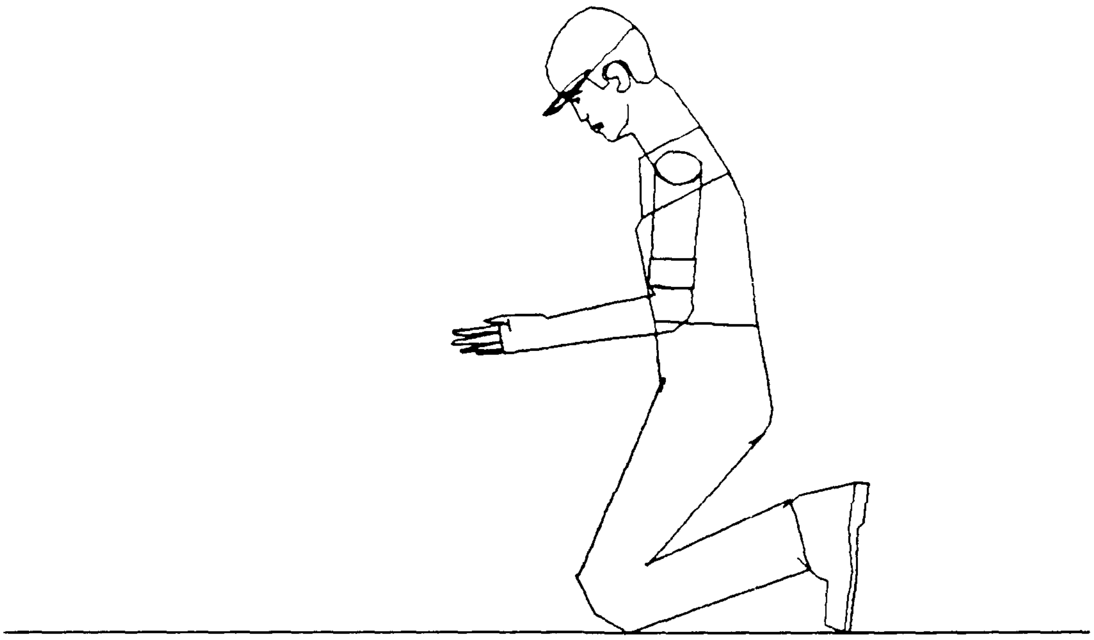


Figure C.8. Initial Kneel Posture, Two Knees, with Position Reference Point on Platform and Centered Between Knees.

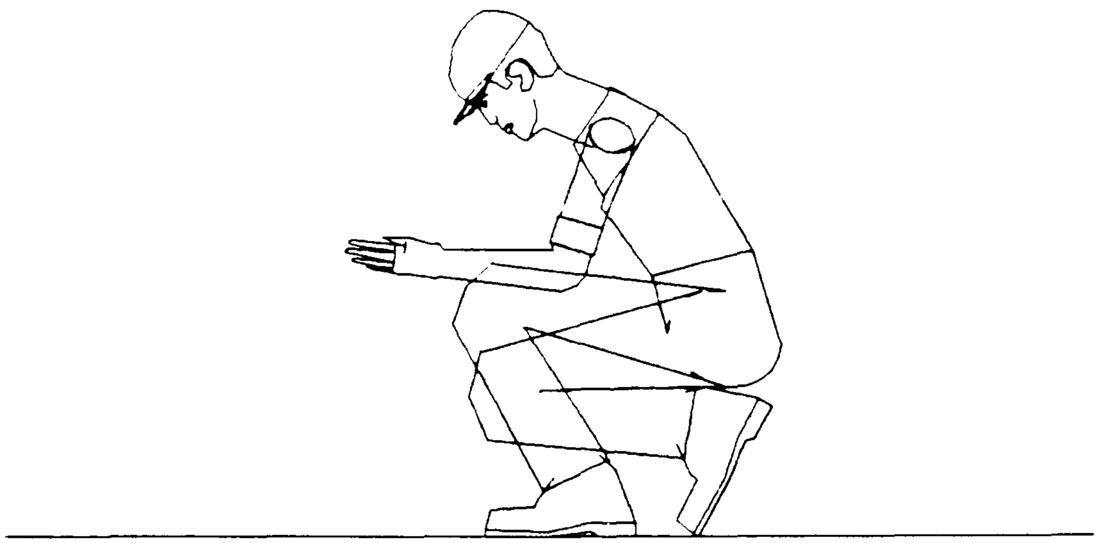


Figure C.9. Initial Squat Posture, with Position Reference Point on Platform and Centered Between the Ankles.

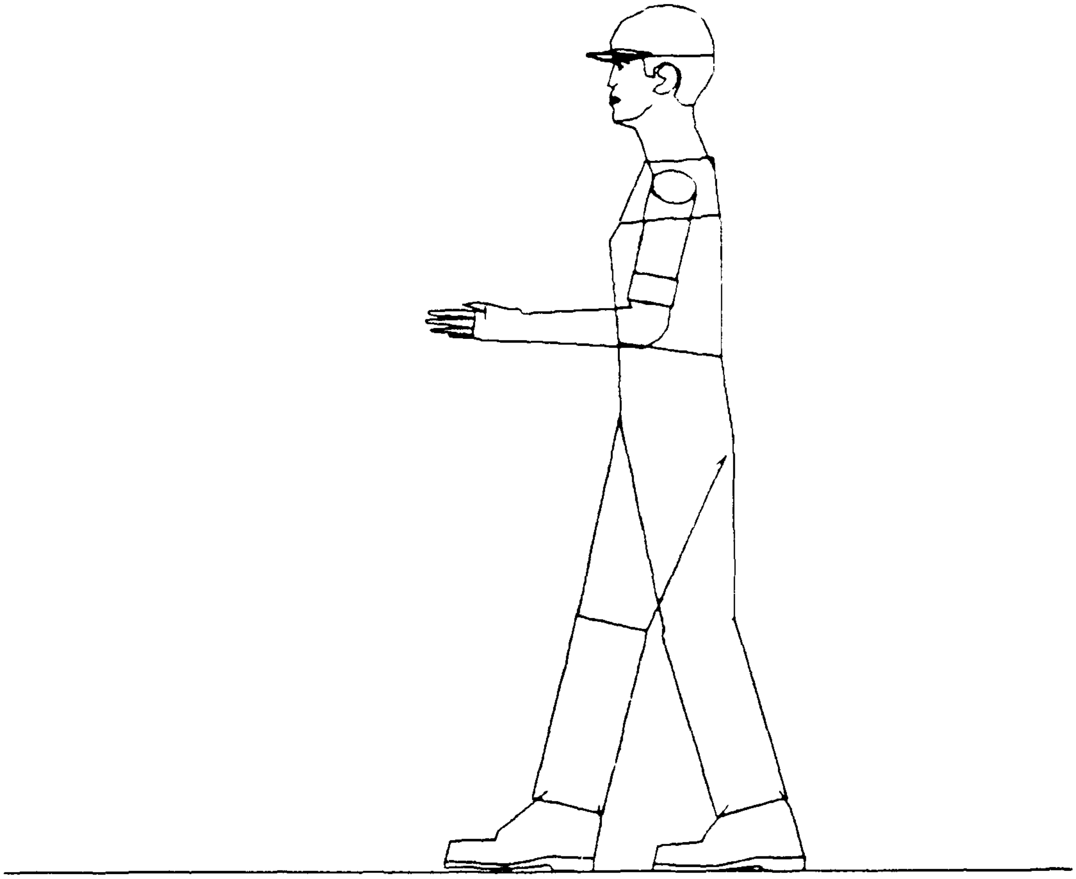


Figure C.10. Initial Walk Posture, with Position Reference Point on Platform and Centered Between the Feet.

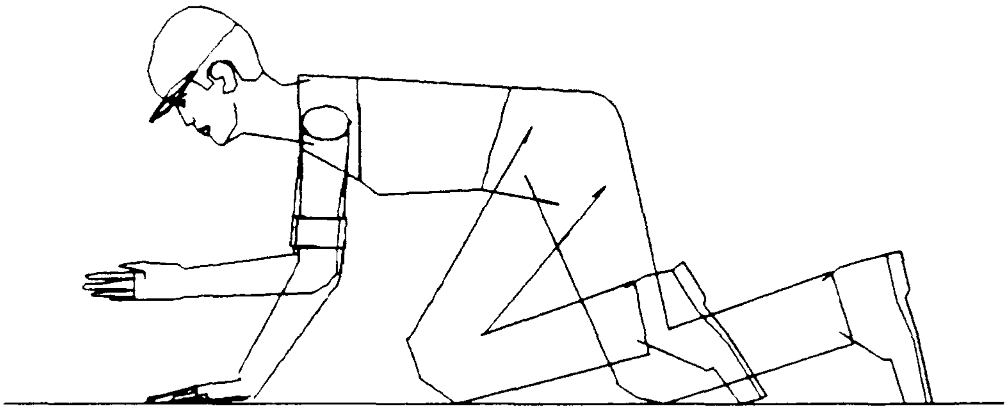


Figure C.11. Initial Crawl Posture, with Position Reference Point on Platform and Centered Between Knees.

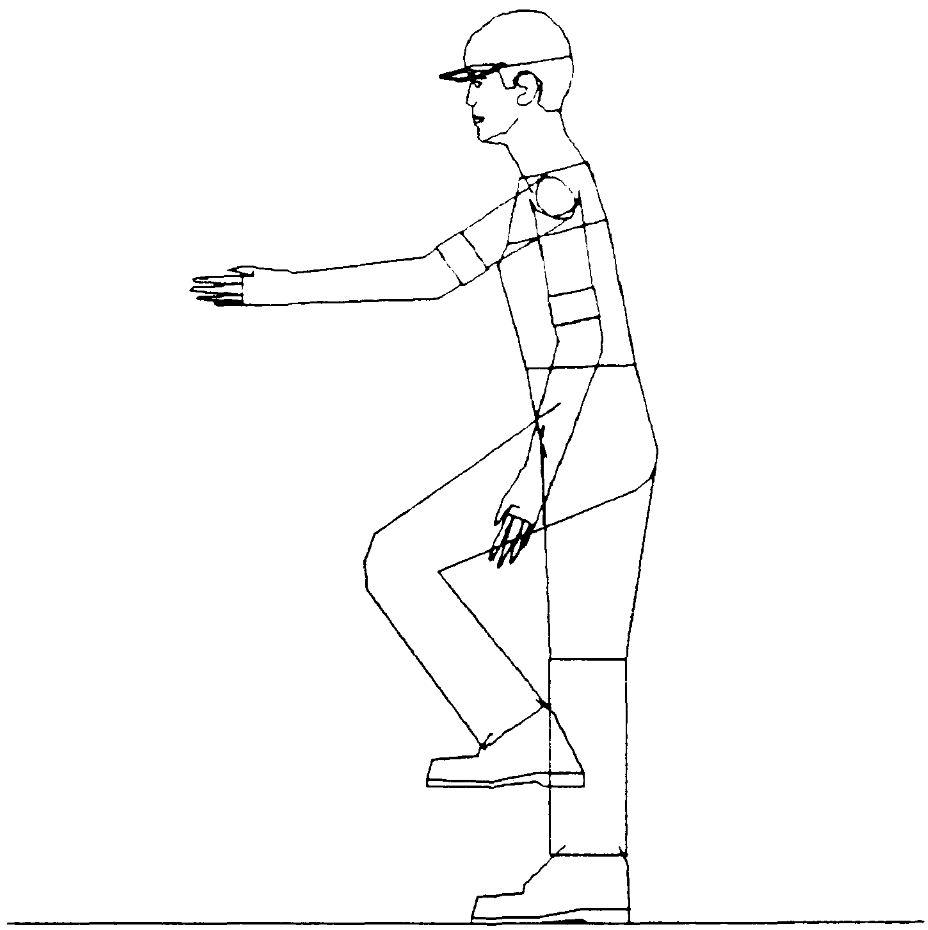


Figure C.12. Initial Climb Posture, with Position Reference Point on Platform and Centered Between the Feet.

APPENDIX D

HAND TOOLS IN CREW CHIEF

APPENDIX D
HAND TOOLS IN CREW CHIEF

D.1 INTRODUCTION

Hand tools commonly used in aircraft maintenance have been included in CREW CHIEF. Evaluations using tools include accessibility (reach interference, work envelope, and visibility) and strength (torque). All tools included in the program are standard tools. Standard tools are defined in MIL-STD 1472C (Reference C.1) as tools (normally hand tools) used for the assembly, disassembly, inspection, servicing, repair, and maintenance of equipment, and which are manufactured by two or more recognized tool manufacturing companies and listed in those companies' catalogs. The appropriateness of the list of tools was verified through interviews with aircraft maintenance managers and technicians at several operational Air Force Bases. Sizing of the tools was based on information in tool catalogs for manufacturers participating in the Air Force warranted tool program.

Tools available for selection are:

ACCESSIBILITY AND TORQUE STRENGTH	
Torque Wrench	Deep Offset Box End
Ratchet Wrench	Ratcheting Box End
Breaker Bar	Open End
Standard Box End	Combination End

Wrenches listed here are shown in Figures D.1 and D.2.

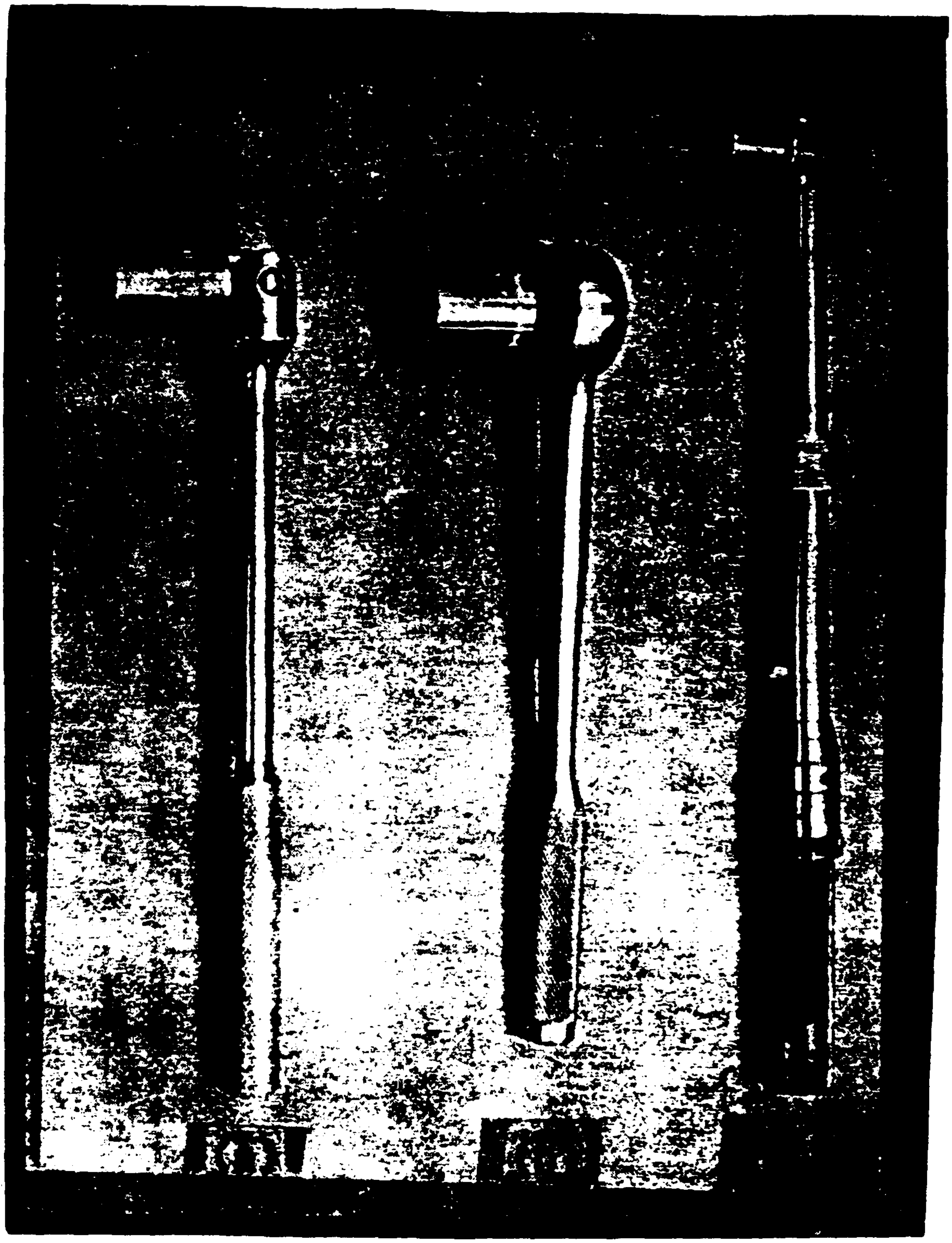


Figure D.1. Socket-Type Wrenches With Strength Analyses Include (a) Breaker Bar, (b) Ratchet Wrench, and (c) Torque Wrench.

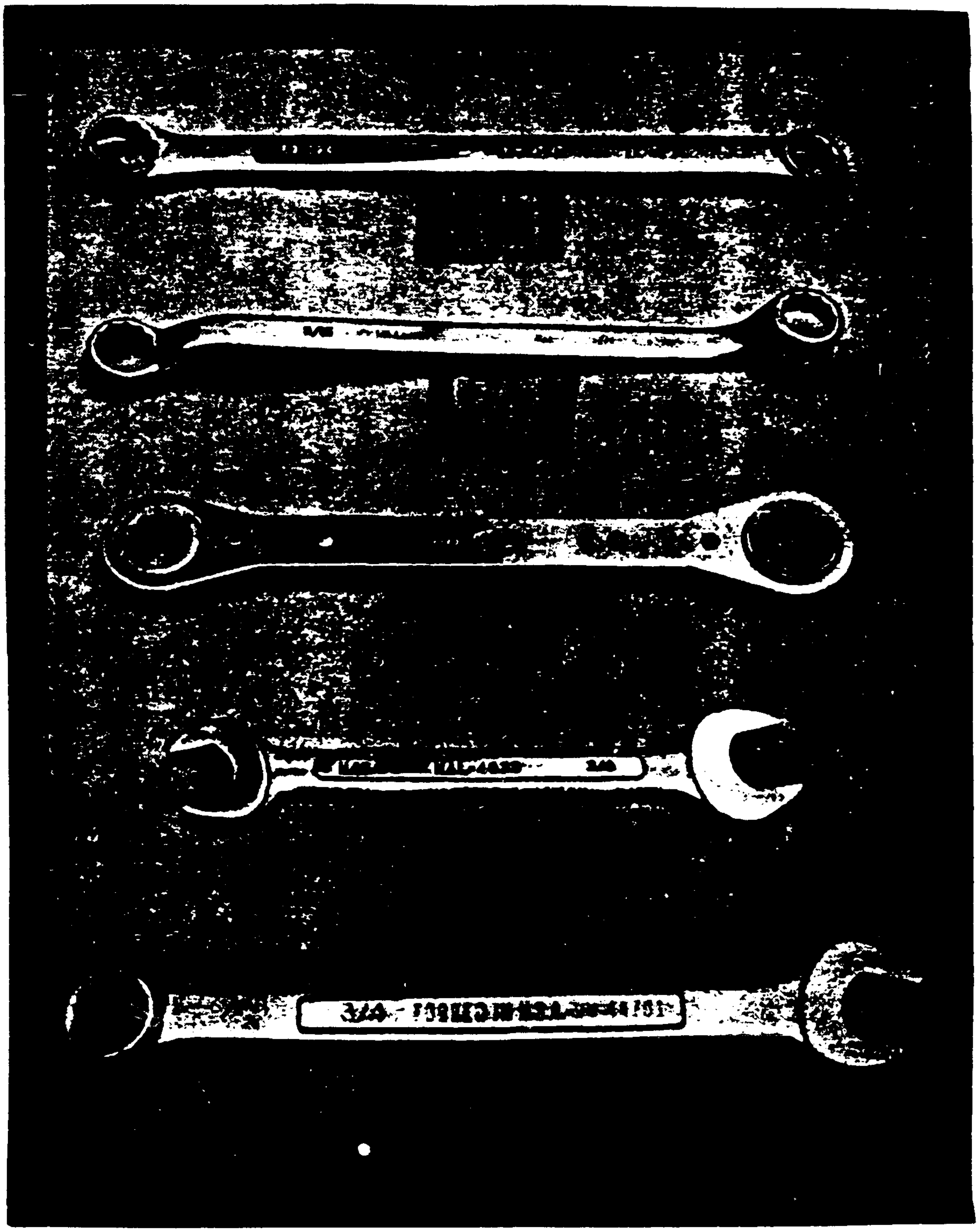


Figure D.2. Common Wrenches With Strength Analyses Include (a) Standard Box End, (b) Deep-Offset Box End, (c) Ratcheting Box End, (d) Open End, and (e) Combination End.

ACCESSIBILITY ONLY

Speed Handle	Hammer with Chisel
Allen Wrench	File
Pliers	Scraper
Screwdriver	Hacksaw
Nutdriver	Power Drill
Hammer	Power Sander

The tools listed here are illustrated in Figures D.3, D.4, D.5, D.6, D.7, and D.8.

D.1.1 WRENCHES

There is a direct relationship between bolt shank diameter and bolt head size. The table below indicates this relationship. Bolts with diameters of less than 3/16 inch are referred to as numbered screws. Dimensions are in inches.

NUMBERED SCREWS		BOLTS	
Diameter	Head Size	Diameter	Head Size
1, 2	1/8	3/16	3/8
3, 4, 5	3/16	1/4	7/16
6, 8	1/4	5/16	1/2
10	5/16	3/8	9/16
		7/16	5/8
		1/2	3/4
		9/16	13/16
		5/8	15/16
		3/4	1-1/4
		7/8	1-5/16
		1	1-1/2

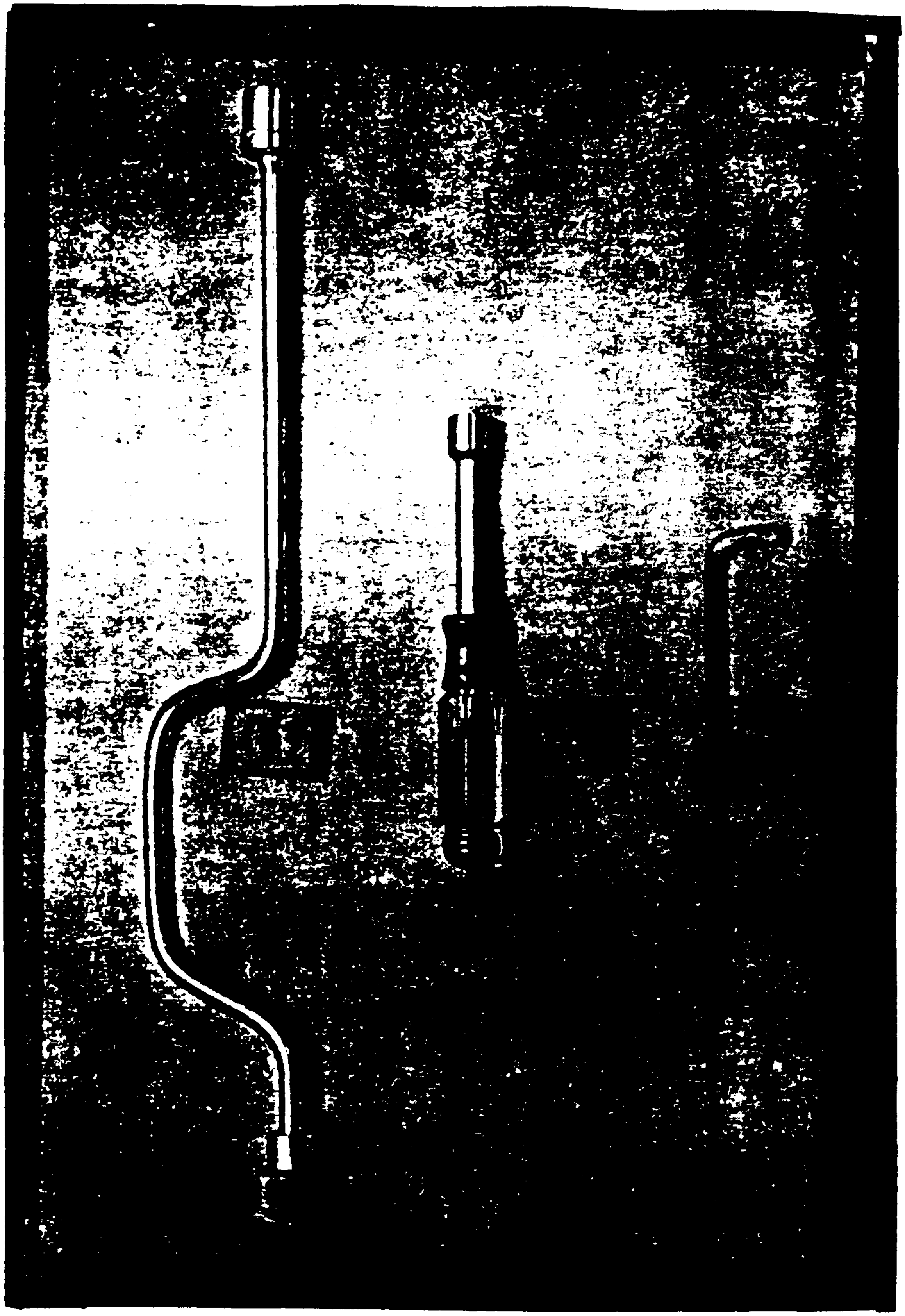


Figure D.3. Wrenches Without Strength Analyses Include (a) Speed Handle, (b) Nutdriver, and (c) Allen Wrench.

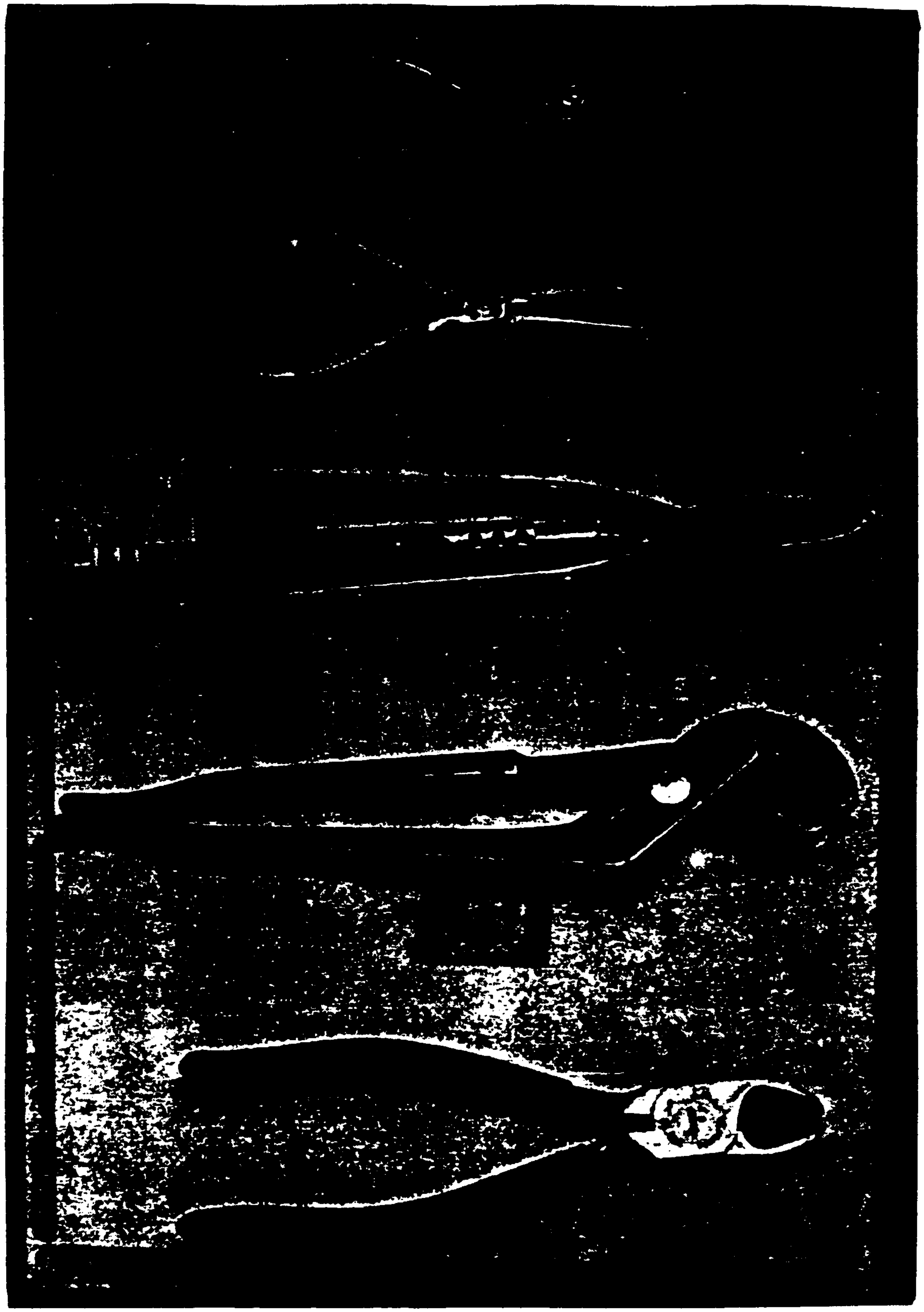


Figure D.4. Plier-Type Tools Include (a) Combination, (b) Needle Nose, (c) Safety Wire, (d) Adjustable Joint, and (e) Wire Cutters.

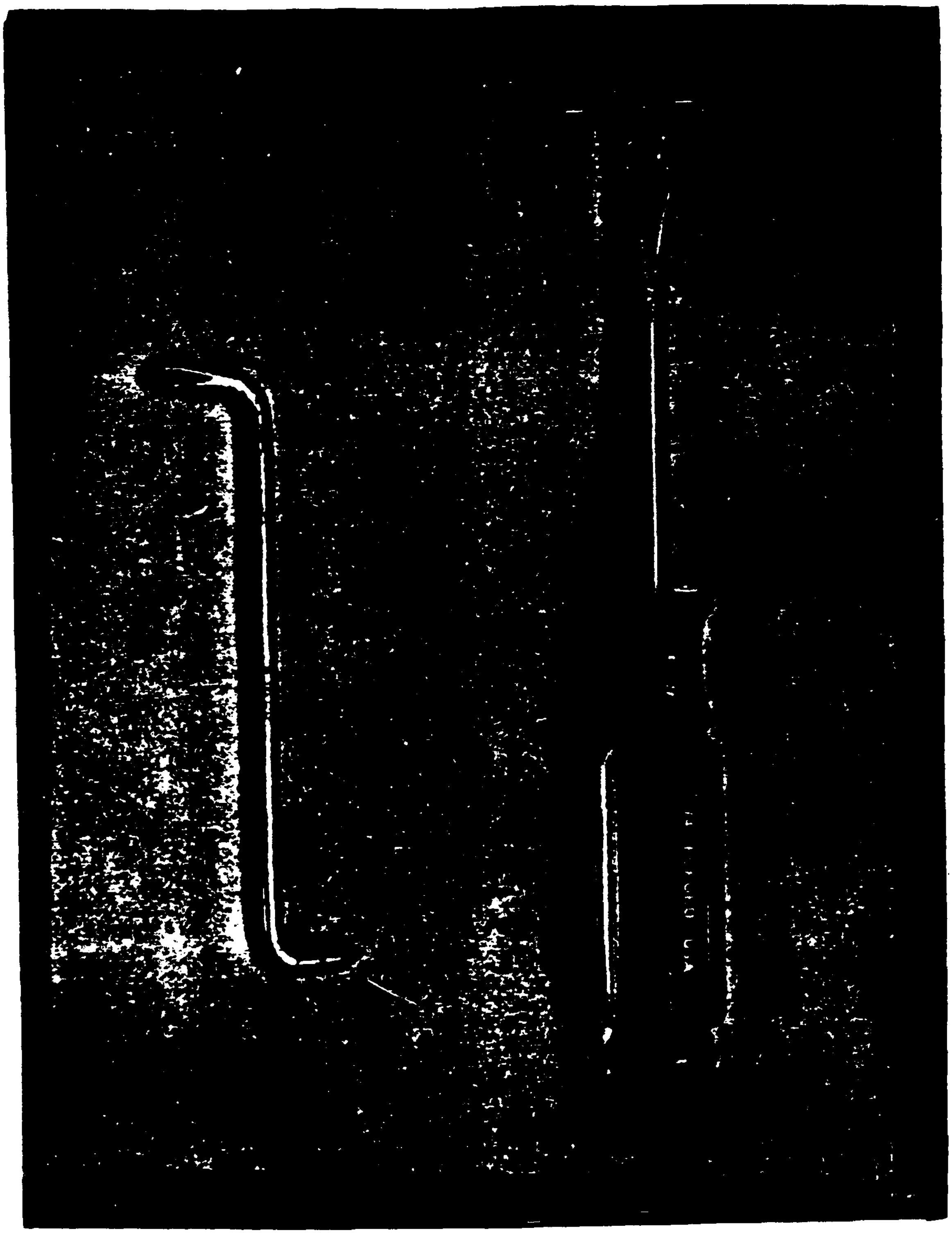


Figure D.5. Screwdrivers Include (a) Offset and (b) Regular.

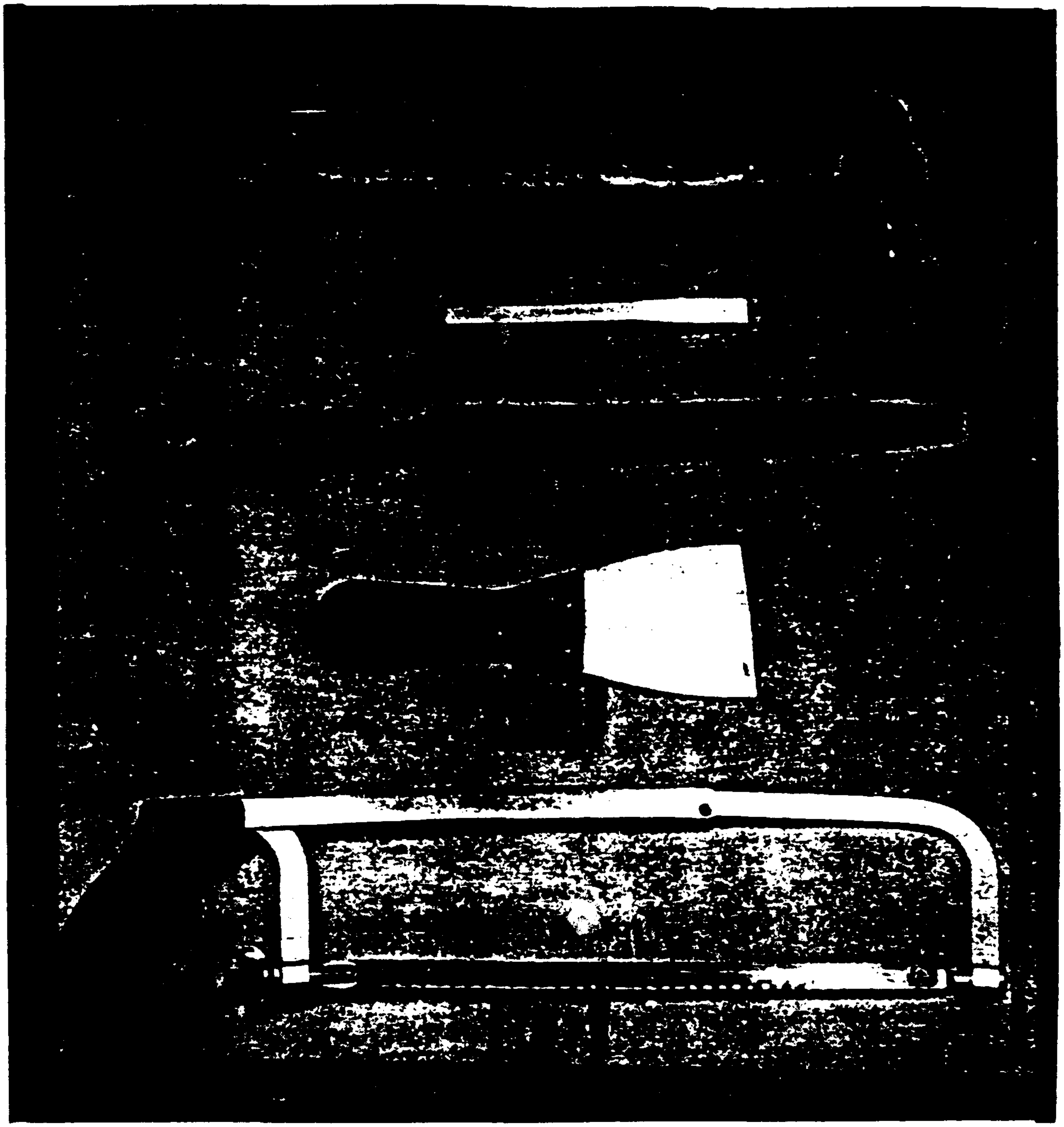


Figure D.6. Miscellaneous Tools Include (a) Hammer, (b) Chisel, (c) File, (d) Scraper, and (e) Hacksaw.

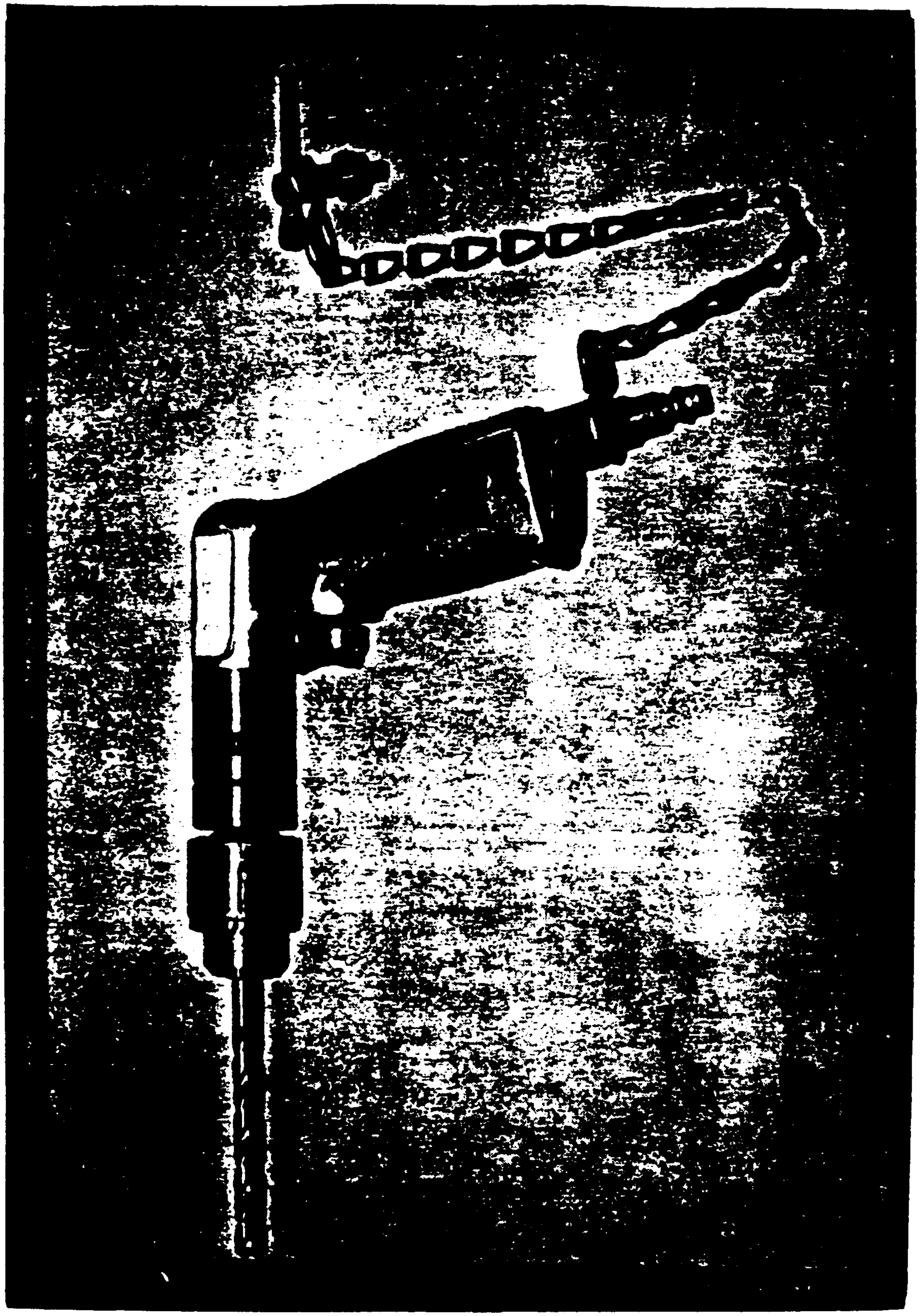


Figure D.7. Power Drill.

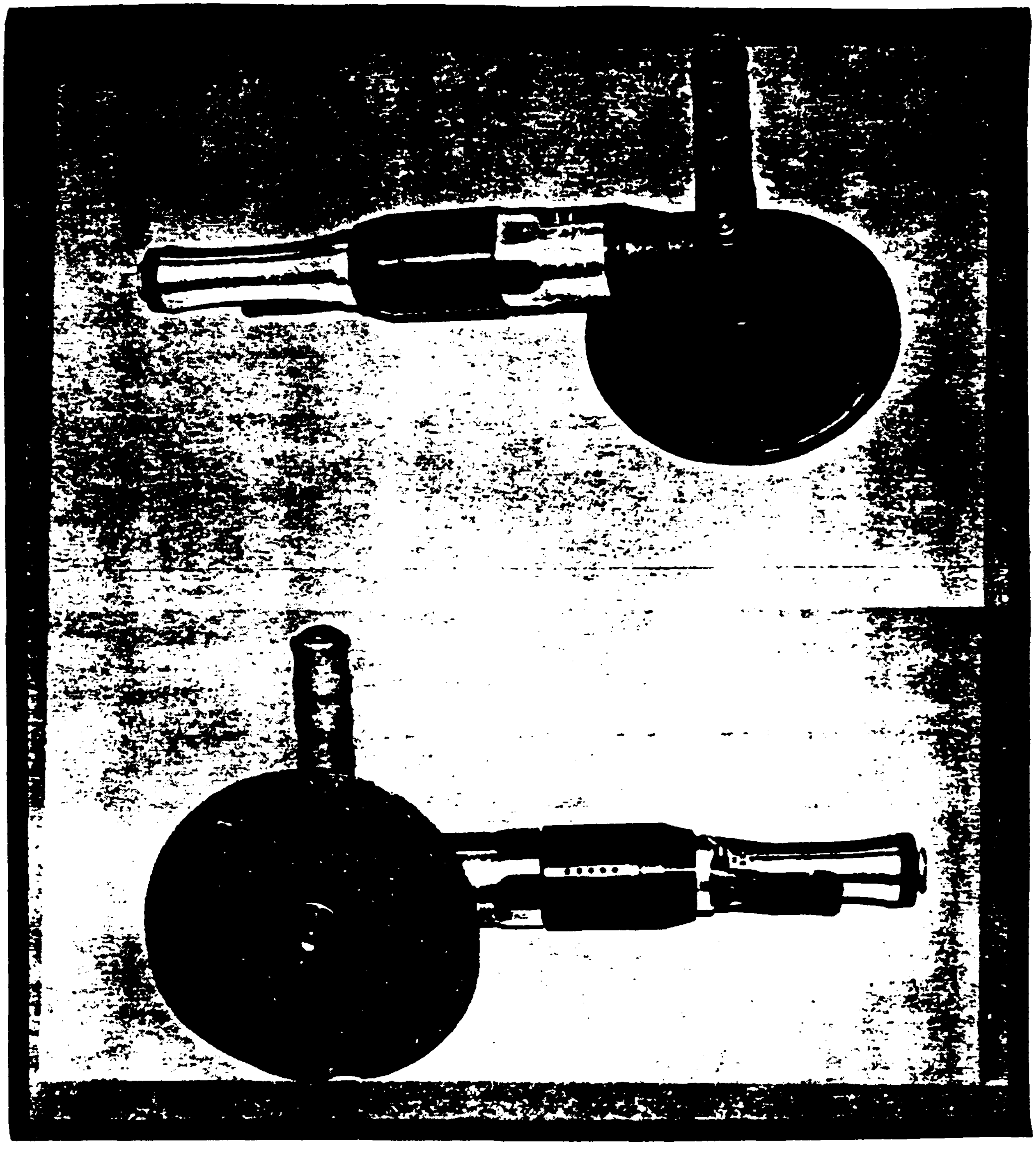


Figure D.8. Power Sander.

In general, the larger the bolt to be turned, the larger the wrench used for the task. For this reason, the wrench sizes in CREW CHIEF are a function of the diameter of the bolt being evaluated.

D.1.1.1 Wrenches with Sockets

For the torque wrench, ratchet wrench, breaker bar, speed handle, and nutdriver (those tools that use sockets) the bolt diameter dictates the tool drive size (1/4, 3/8, or 1/2 inch), and handle lengths in CREW CHIEF correspond to those common for that drive size. Bolt diameters that correspond to each drive size are:

BOLT DIAMETER	DRIVE SIZE
Numbered Screws 1-10	1/4 inch
3/16 to 1/2 inch	3/8 inch
9/16 to 1 inch	1/2 inch

Handle lengths in CREW CHIEF, in inches, are:

	1/4-INCH DRIVE		3/8-INCH DRIVE		1/2-INCH DRIVE	
	Standard	Long	Standard	Long	Standard	Long
Torque Wrench	6.0	9.5	9.5	14.5	20.8	36.0
Ratchet Wrench	5.4	6.5	7.5	10.3	10.3	15.0
Breaker Bar	6.0	9.5	9.5	11.5	15.0	24.0
Speed Handle (Sweep)	3.0	N/A	3.3	N/A	4.1	N/A

D.1.1.1.1 Extensions

Extensions may be used with torque wrenches, ratchet wrenches, and breaker bars to improve accessibility. Extensions of 3, 6, and 12 inches are available in CREW CHIEF. An extension is shown in Figure D.9(a).

D.1.1.1.2 Sockets

Four types of sockets are included in CREW CHIEF:

1. Regular
2. Deep
3. Universal
4. Hex Drive.

Sockets are shown in Figure D.9(b-e).

D.1.1.2 Wrenches Without Sockets

Bolt diameter dictates the wrench head size for the standard box end, deep offset box end, ratcheting box end, open end, combination end, allen wrenches, and nutdriver. (The nutdriver in CREW CHIEF is a one-piece tool.) CREW CHIEF automatically selects the handle length appropriate for the wrench head size for the type of wrench selected by the user. CREW CHIEF selects the handle length for the allen wrench that is appropriate for the grip selected by the user.

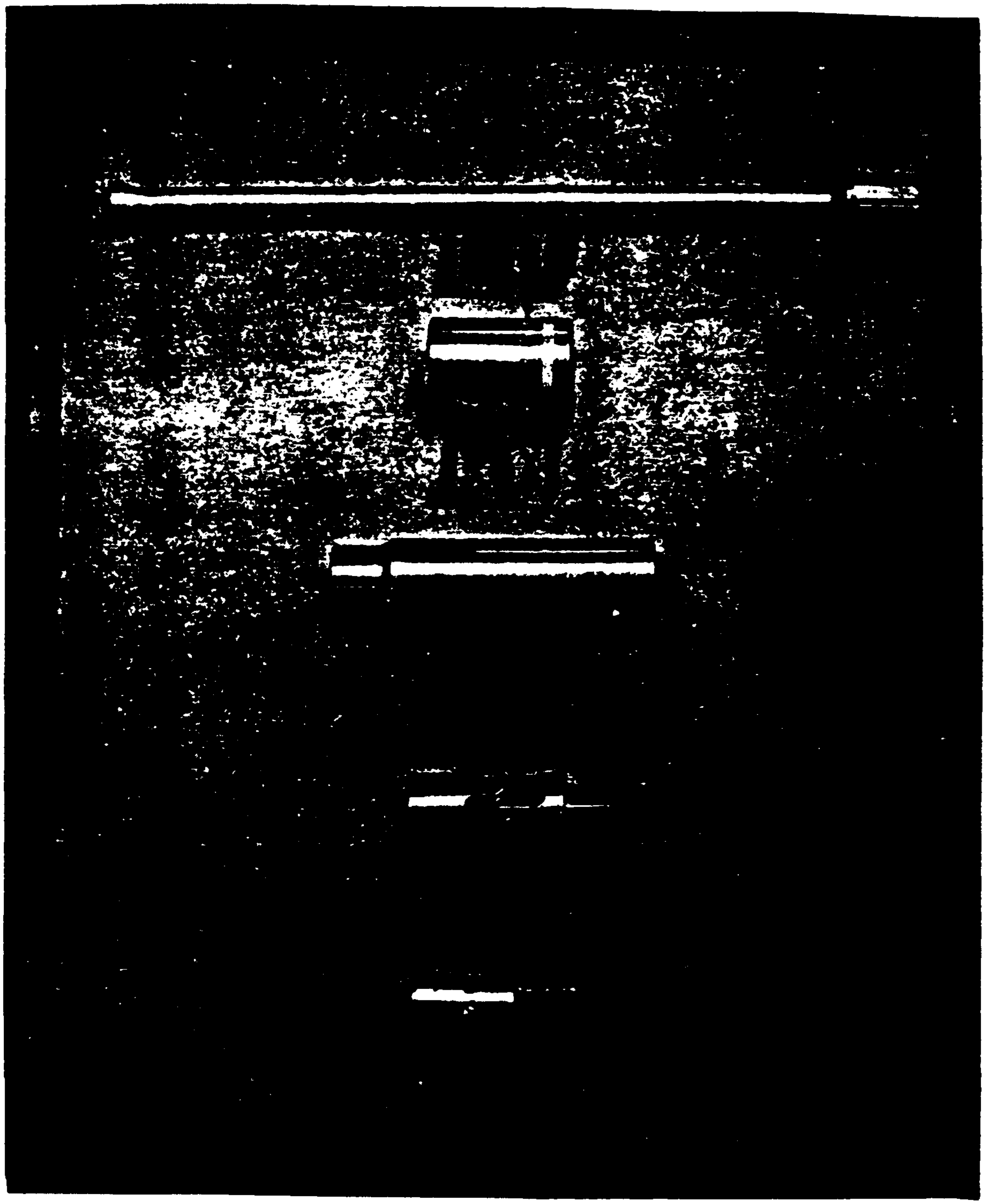


Figure D.9. Extensions and Sockets Include (a) Extension, (b) Regular Socket, (c) Deep Socket, (d) Universal Joint, and (e) Hex Drive.

Handle lengths in CREW CHIEF, in inches, are:

STANDARD BOX END	
Bolt Diameter	Length
#4, 5,	2.8
#6, 8, 10	3.6
3/16 - 1/4	7.6
5/16 - 3/8	8.8
7/16 - 15/32	10.0
1/2 - 9/16	11.1
19/32 - 5/8	12.8
21/32 - 11/16	13.6
>11/16	16.0

DEEP OFFSET BOX END

Bolt Diameter	Length
#6, 8, 10	4.2
3/16 - 1/4	7.5
5/16 - 3/8	8.5
7/16 - 15/32	9.5
1/2 - 9/16	10.5
19/32 - 5/8	12.2
>5/8	13.1

RATCHETING BOX END

Bolt Diameter	Length
#6, 8, 10	4.3
3/16 - 1/4	5.5
5/16 - 3/8	7.0
7/16 - 15/32	7.0
1/2 - 9/16	7.8
19/32 - 5/8	8.7
21/32 - 11/16	10.0
>11/16	12.8

OPEN END

Bolt Diameter	Length
#4, 5	2.8
#6, 8, 10	4.0
3/16 - 1/4	5.3
5/16 - 3/8	6.5
7/16 - 15/32	7.7
1/2 - 9/16	9.3
19/32 - 5/8	10.8
21/32 - 11/16	11.6
>11/16	13.9

COMBINATION END

Bolt Diameter	Length
#6, 8, 10	4.7
3/16 - 5/16	7.3
3/8 - 7/16	8.3
15/32	9.0
1/2	10.0
9/16 - 19/32	11.3
5/8	13.0
11/16	14.0
>11/16	16.9

ALLEN WRENCH

Bolt Diameter	Short	Long
#1, 2, 3	0.6	1.5
#4 - 10	0.9	2.3
3/16 - 3/8	1.3	3.3
7/16 - 5/8	1.9	4.8
>5/8	2.7	6.8

NUTDRIVER	
BOLT DIAMETER	LENGTH
#1-10	6.6
3/16-7/16	7.3

D.1.2 SCREWDRIVERS

Screwdrivers in CREW CHIEF include regular and offset. No distinction is made between standard and crosspoint screwdrivers. Regular screwdrivers are available with the following blade lengths: 1.5, 3, 4, 6, 8, 10 and 12 inches. Two lengths of offset screwdrivers are included: 4.5 and 6 inches.

D.1.3 PLIER-TYPE TOOLS

There are five plier-type tools included in CREW CHIEF:

1. Combination
2. Needle nose
3. Safety wire
4. Adjustable joint
5. Wire cutters.

One size of each of these pliers is included. Therefore, selecting the type of pliers defines the tool size and no other definition is necessary.

D.1.4 MISCELLANEOUS TOOLS

The hammer (ball peen), hammer with chisel, file, scraper, hacksaw, power drill, and power sander are limited to one size each in CREW CHIEF. Therefore, a selection of any of these tools completely defines the tool and no other selections are necessary.

D.2 SELECTING THE PROPER TOOL

When evaluating maintenance tasks that require a tool, the user is faced with choosing the tool that is most appropriate. Often the choice will be evident because the function of the tool is unique in the program, that is, no other tool will do the job. For example, if the task to be evaluated involves determining whether the design provided sufficient space to properly safety-wire an aircraft part, the obvious choice would be the safety wire pliers. At times, however, the choice may not be so clear. A bolt or nut can be torqued with any of several tools included in the program. Likewise, screwdrivers of different lengths may be used with equal success for the same task. The following information and recommendations should make the choice easier.

D.2.1 TOOLS WITH STRENGTH EVALUATION

Strength analyses with tools are available for wrenches only. No other tool strength limitations are considered pertinent to maintainability problems caused by design. Torque capabilities are available with eight of the tool types in CREW CHIEF. These eight tools are used to apply high torque to nuts and bolts.

D.2.1.1 Torque Wrench

The torque wrench must be used when a bolt or nut must be torqued to a specific value dictated by the specific aircraft maintenance technical order. Likewise, this tool is never used if a specific torque value is not required by this technical order. Generally, specific values will be designated if they are critical to safety or proper aircraft operation. Use of a universal joint produces erroneous torques on the bolt, and therefore, the use of the universal is disallowed with the torque wrench.

D.2.1.2 Other Wrenches with Strength Evaluation

The seven other wrenches with strength analyses in the program can be used whenever a specific torque value is not required by the specific aircraft technical order. In these cases, general torque recommendations based on bolt and nut types and sizes can be found in the USAF Technical Order 1-1A-8, "Aircraft and Missile Repair - Structural Hardware" (Reference D.2). These seven wrenches are often chosen by the maintenance technician according to personal preference and/or the tool's accessibility traits in relation to the task. The following is a recommended order of preference for the selection of these seven wrenches.

1. Ratchet
2. Ratcheting box end
3. Breaker bar
4. Combination end
5. Standard box end
6. Deep offset box end
7. Open end (NOTE: It should be obvious that only the open end wrench can be used on tasks involving connections for various lines such as fuel and hydraulic lines.)

D.2.2 TOOLS WITHOUT STRENGTH EVALUATION

D.2.2.1 Wrenches

Three wrenches are included in the CREW CHIEF Program that do not have strength analyses available. Lack of technician's strength while using these tools is not a common maintenance problem.

SPEED HANDLE: As its name implies, the shape of the speed handle allows the technician to turn fasteners at a rapid rate. For this reason, it is used for tasks that require removal

or installation of numerous bolts or screws. The prime example is an aircraft access panel that has bolts/screws along its entire perimeter. The speed handle is not useful for applying high torque because of the short moment arm of the sweep.

ALLEN WRENCH: This tool is used on light tasks that require tightening and loosening of internal hex head fasteners. Selection of this tool in the program should be apparent by the task to be evaluated.

NUTDRIVER: This tool is used on small bolts/nuts that are easily turned and especially in recessed areas that do not allow the use of other wrenches. It is commonly used in avionics and electrical system maintenance.

D.2.2.2 Plier-Type Tools

The five types of pliers included in the program (combination, needle nose, safety wire, adjustable joint, and wire cutters) are very common and the appropriate selection of each should be fairly evident to the user based upon the task to be evaluated.

COMBINATION PLIERS: These are the most common pliers. They are used as gripping tools. They should be selected in preference to the other plier-type tools for general gripping tasks. The other four have specific functions and should only be selected if the task corresponds to that specific function.

NEEDLE NOSE PLIERS: These pliers have jaws that are long and slender. They are designed for gripping small objects and for use in areas of restricted access.

ADJUSTABLE JOINT PLIERS: These pliers have jaws that will open wide and are designed for gripping larger objects than can be gripped with the combination pliers. They tend to be large overall and are not useful in areas of limited access.

WIRE CUTTERS: This tool is used only for cutting electrical wire. No other tool in CREW CHIEF should be selected for this function.

SAFETY WIRE PLIERS: This tool has a very specific purpose. It is used only for twisting wire during safety wiring tasks. No other tool should be selected for this task.

D.2.2.3 Screwdrivers

There are two types of screwdrivers in the program: regular and offset. Regular screwdrivers include standard and crosspoint; that is, no distinction is made in the point types. Regular screwdrivers should be selected in preference to offset screwdrivers. The offset screwdriver is normally used only if necessary because of lack of access with regular screwdrivers. Regular screwdrivers are selected in the program by blade length (1.5, 3, 4, 6, 8, 10, and 12 inches). It is recommended that the user first select the median length (6 inches) as the preferred length and subsequently choose shorter or longer blades as the design dictates.

D.2.2.4 Miscellaneous Tools

All other tools in the CREW CHIEF Program (hammer, hammer with chisel, file, scraper, hacksaw, drill, and sander) have unique functions and their appropriate selection should be evident by the task to be evaluated.

APPENDIX E

ANTHROPOMETRIC DATA BASE MAINTENANCE PROGRAM (AMPREG)

APPENDIX E

ANTHROPOMETRIC DATA BASE MAINTENANCE PROGRAM (AMPREG)

The human model used in CREW CHIEF is based on the anthropometry of Air Force maintenance technicians. However, the CREW CHIEF program has applications in many areas of maintenance, and so need not be restricted to representing a single population. These additional populations may be created and stored in the Anthropometry/Regression data base, and then used during a CREW CHIEF analysis.

This data base can be accessed through a data base maintenance program, AMPREG, which allows for general data management of the Anthropometry/Regression Data Base. AMPREG allows a CREW CHIEF user to add virtually any population to this data base, compress the data base, and generate reports on the data base.

There are three anthropometric variables which are crucial to maintainability analysis :

- Stature,
- Weight, and
- Arm Length

Stature and Weight are standard anthropometric variables found in most surveys. Arm Length is defined by three other anthropometric variables found in most surveys.

Arm Length = Acromion-Radiale + Radiale-stylion + Hand Length

These three variables are used as a basis for calculating 10 additional variables which, along with stature and weight, are used for defining the human model skeletal system and enfleshment. AMPREG allows the user to represent a population by altering either the data for these three variables, or the

equations used to calculate the data for the 10 variables. Note that the Arm Length must be calculated for each individual, and then the overall percentiles determined from this set of Arm Lengths. A 5th percentile length is **not** the sum of the 5th percentile values of the Acromion-Radiale, Radiale-Stylion and Hand Length.

Data for the three anthropometric variables can be altered by adding an Anthropometric Member to the data base. This member will contain data defining the percentile data for each of the three variables. Each Anthropometric Member must reference a set of regression equations from which data for the 10 additional variables can be calculated.

Regression equations are stored in a second type of data base member, called a Regression Member. These equations further define the CREW CHIEF model, and may vary from population to population. When referencing a Regression Member from an Anthropometric Member, the AMPREG user should take care that the regression equations will accurately represent a desired population. For instance, a subpopulation of Japanese pilots would not be well represented by referencing regression equations based on an American population. They would be represented much better by referencing regression equations based on the general Japanese population. Of course, the best representation of a subpopulation would be to reference regression equations based on the same subpopulation.

E.1 AMPREG CONTROL STATEMENTS

All data base management is performed through control statements input through the //USRINPT DD statement in the AMPREG execution JCL. While processing a control statement, AMPREG assumes that the //DATABAS DD statement points to the location of the data base. This section discusses each of these control statements in detail.

• FORMAT BASTTL

The FORMAT control statement formats a NEW data base prior to adding any members. **CAUTION:** If the FORMAT control card is input for an existing data base, all members in that data base will be lost.

FORMAT: (A10,1X,A32)

BASTTL- Title of new Anthropometry/Regression data base (contained in a field of 32 characters).

• ADD TYPE MBRTTL

The ADD control statement is used to add a member to the data base. This control statement must always be followed by a DATA control statement (see below) which defines the location of the data. Both Regression and Anthropometric Members are entered using this control statement, as specified by the TYPE variable.

FORMAT: (A10,1X,A14,1X,A32)

TYPE - Type of member to be entered
= 'ANTHROPOMETRIC', Anthropometric Member.
= 'REGRESSION', Regression Member.

MBRTTL- Title of member. Note: the title of each member must be unique within that type. For instance, there can be only one Anthropometric Member entitled "Japanese Maintenance Technicians." However, a Regression Member may have the same name as a Anthropometric Member.

- ERASE TYPE MEMBER

The ERASE control statement allows the user to delete a member from the data base.

FORMAT: (A10,1X,A14,1X,A32)

TYPE - Type of member to be erased.
MEMBER - The name of the member to be erased.

- COPY TYPE MEMBER

The COPY control statement is used t copy a member from one Anthropometry/Regression data base to another. This function can be used to merge data bases, or to selectively copy members from one or more data bases. The COPY control statement must be followed by a DATA control statement defining the DDNAME of the data base from which you are copying. The member will be copied into the database pointed to by the //DATABAS DD statement.

FORMAT(A10,1X,A14,1X,A32)

TYPE - Type of member to be copied.
MEMBER - The name of the member to be copied.

- REPORT <TYPE> <MEMBER>

The REPORT control statement prints out general information on the Anthropometry/Regression data base. If no member is specified, general information on the entire data base is output. Otherwise, a somewhat more detailed report for the specified member is output.

FORMAT: (A10,1X,A14,1X,A32)

<TYPE>: The type of member whose report is desired (OPTIONAL OPERAND).

<MEMBER>: The name of the member whose report is desired (OPTIONAL OPERAND).

- PRINT <u><TYPE> <MEMBER></u>

The PRINT control statement can be used to obtain a complete print-out of data for the member specified or, alternately, for all members in the data base.

FORMAT: (A10,1X,A14,1X,A32)

<TYPE>: Type of member to be printed
<MEMBER>: The name of the member to be printed (OPTIONAL OPERAND).

- DATA <u>DDNAME</u>

The DATA control statement is used to indicate the location of input data for the Anthropometric and Regression Members. Rather than placing these data in-stream, AMPREG uses this statement to locate a file containing the data. Note that each ADD control statement must be followed by a DATA control statement.

FORMAT: (A10,1X,A8)

DDNAME - The name of the data definition JCL statement which points to the dataset containing the input data.

E.2 EXECUTING THE AMPREG PROGRAM

Figure E.1 shows sample JCL for executing the AMPREG program. This example formats a new database, and then adds a Regression Member and an Anthropometric Member.

The first control statement under the //USRINPT DD statement (line #6000) requests that the database be formatted, and given

the name "SAMPLE DATABASE." The next record (line #6100) requests that a new Regression Member, called "SAMPLE REGRESSION MEMBER," be added to the database. The DATA control statement immediately following the ADD statement specifies that the input data for the Regression Member can be found in the data set pointed to by the //REGIN DD statement (line #4500).

The next control statement (line #6300) requests that a new Anthropometric Member, called "SAMPLE ANTHROPOMETRIC MEMBER," be added to the database. The DATA control statement immediately following this ADD statement specifies that the input data for the member can be found in the data set pointed to by the //ANTHIN DD statement (line #3600).

Note that in this example, if the new Anthropometric Member is to reference the new Regression Member, the Regression Member must be added first. Note also that the the input data for the two new members need *not* necessarily reside in the same Partitioned Dataset.

E.3 DATA INPUT FORMATS

The dataset pointed to by the DATA control statement contains specific information needed for defining a member. The necessary information is different for Regression Members and Anthropometric Members, so input formats vary between the two.

E.3.1 Anthropometric Data Input Format

The first portion of the anthropometry input dataset contains general information for the member. The first record contains,

```
//jobname  JOB account_number,programmer_name,CLASS=A,MSGCLASS=A
//**********************************************************************
//*                                                                    *
//*                          PROGRAM AMPREG                            *
//*                                                                    *
//*--------------------------------------------------------------------*
//*    THIS IS SAMPLE JCL FOR EXECUTING THE CREW CHIEF DATABASE        *
//* MAINTENANCE PROGRAM AMPREG, WHICH ALLOWS THE CREW CHIEF USER TO    *
//* DEFINE BODY SIZES BASED ON A POPULATION OTHER THAN THE AF          *
//* MAINTENANCE TECHNICIAN POPULATION.  THIS JCL ASSUMES THE           *
//* FOLLOWING:                                                         *
//*                                                                    *
//*        1. THE USER WANTS TO CREATE A NEW CREW CHIEF DATABASE IN    *
//*           THE DATA SET 'CREW.CHIEF.SAMPLE.ANTHREG.DATA'.           *
//*        2. THE INPUT DATA FOR THE ANTHROPOMETRIC AND REGRESSION     *
//*           MEMBERS CAN BE FOUND IN 'CREW.CHIEF.SAMPLE.SOURCE'.      *
//*                                                                    *
//**********************************************************************
//*
//AMPREG   EXEC PGM=AMPREG
//STEPLIB  DD   DSN=CREW.CHIEF.CADAM.LOAD,DISP=SHR,LABEL=(,,,IN)
//*
//* +++ THE NEW DATABASE IS POINTED TO BY THE //DATABAS DD
//* +++ STATEMENT.  ALL AMPREG CONTROL STATEMENTS ACT ON THE
//* +++ DATA SET POINTED TO BY THIS DD.
//*
//DATABAS DD   DSN=CREW.CHIEF.SAMPLE.ANTHREG.DATA,DISP=(NEW,CATLG),
//             SPACE=(???,(???,???)),UNIT=DISK,VOL=SER=CCFDSK
//*
//* +++ THE ANTHROPOMETRIC MEMBER INPUT DATA IS POINTED TO BY
//* +++ THE //ANTHIN DD STATEMENT.  THIS DD STATEMENT WAS SPECIFIED
//* +++ BY THE 'DATA' CONTROL STATEMENT FOLLOWING THE 'ADD'
//* +++ ANTHROPOMETRIC MEMBER CONTROL STATEMENT IN THE //USRINPT
//* +++ DD.
//*
//ANTHIN   DD   DSN=CREW.CHIEF.SAMPLE.SOURCE(ANTHIN),DISP=SHR,
//             LABEL=(,,,IN)
//*
//* +++ THE REGRESSION MEMBER INPUT DATA IS POINTED TO BY
//* +++ THE //REGIN DD STATEMENT.  THIS DD STATEMENT WAS SPECIFIED
//* +++ BY THE 'DATA' CONTROL STATEMENT FOLLOWING THE 'ADD'
//* +++ REGRESSION MEMBER CONTROL STATEMENT IN THE //USRINPT
//* +++ DD.
//*
//REGIN    DD   DSN=CREW.CHIEF.SAMPLE.SOURCE(REGIN),DISP=SHR,
//             LABEL=(,,,IN)
//*
//* +++ THE //USRINPT DD STATEMENT CONTAINS THE CONTROL STATEMENTS
//* +++ FOR DRIVING THE AMPREG PROGRAM.  IN THIS EXAMPLE, THE PROGRAM
//* +++ IS TOLD TO:
//* +++
//* +++     1. FORMAT THE DATABASE, AND NAME IT 'SAMPLE DATABASE'
//* +++     2. ADD A REGRESSION MEMBER CALLED 'SAMPLE
//* +++        REGRESSION MEMBER', WHOSE INPUT DATA ARE POINTED TO
//* +++        BY THE DD STATEMENT //REGIN.
//* +++     3. ADD AN ANTHROPOMETRIC MEMBER CALLED 'SAMPLE
//* +++        ANTHROPOMETRIC MEMBER', WHOSE INPUT DATA ARE
//* +++        POINTED TO BY THE DD STATEMENT //ANTHIN.
//USRINPT DD *
FORMAT     SAMPLE DATABASE
ADD        REGRESSION     SAMPLE REGRESSION MEMBER
DATA       REGIN
ADD        ANTHROPOMETRIC SAMPLE ANTHROPOMETRIC MEMBER
DATA       ANTHIN
/*
//
```

Figure E.1: Sample JCL for Executing the AMPREG Anthropometry/Regression Database Maintenance Program.

- NUMCMT GENDR REGNAM

FORMAT(I2,1X,A6,1X,A32)

NUMCMT- Total number of records needed to contain all the general member comments.

GENDR - Gender indicator.
= 'NONE', if not gender-specific.
= 'MALE', if male population.
= 'FEMALE', if female population.
= 'BOTH', if member contains both male and female data.

REGNAM- The name of the reference regression data base. Note that if a particular Anthropometric Member contains both male and female data (GENDR= 'BOTH'), then the referenced Regression Member must also contain data for both.

The next set of records contain informational text on the origins of the member. This block may contain information on data editing, data validity, or any other type of historical information.

- COMENT

FORMAT(A72)

COMENT- Informational text.

The remainder of the dataset contains percentile data for each of the five variables. Each set of variable data is input using two lines, one defining the type of data, and one defining the actual data, itself.

• <u>VARNAM GENDR</u>

FORMAT(A20,1X,A6)

This record defines the name of the variable for which data is being input. The variable name must be input exactly as seen in Table E.1. The next field, separated by a blank from the first, specifies the gender which the data describes. The gender need be specified only when the member is to contain both male and female data.

• <u>(PCTVAL(I), I=1,5)</u>

FORMAT(F10.4,4(2X,F10.4))

This record contains the percentile data for the variable described in the preceding record. The data is ordered according to increasing percentile (i.e., PCTVAL(1) contains the data for the 1^{st} percentile, PCTVAL(2) contains the data for the 5^{th} percentile, etc.).

The above two records must be input for each of the five variables used to generate the human model. In addition, if the member is to contain both genders, each variable must be entered twice-- once for males and once for females.

E.3.2 <u>Example Anthropometric Member Addition</u>

Figure E.2 shows a partial listing of typical input for creating an Anthropometric Member. These data are contained in the data set pointed to by the DD statement specified in the DATA control statement following the ADD control statement under the //USRINPT DD statement (recall Figure 1). The first line of data in Figure 2 (line # 100) specifies that there are 12 lines of comments following the first record, that the new Anthropometric

TABLE E.1

VARIABLES USED FOR DEFINING CREW CHIEF

VARIABLE NAME	REGRESSED FROM
SITTING HEIGHT	STATURE
ACROMION HEIGHT/SITTING	STATURE
KNEE HEIGHT/SITTING	STATURE
BUTTOCK-KNEE LENGTH	STATURE, WEIGHT
BIACROMIAL BREADTH	STATURE, WEIGHT
HIP BREADTH	STATURE, WEIGHT
CHEST DEPTH	STATURE, WEIGHT
FOOT LENGTH	STATURE
SHOULDER-ELBOW LENGTH	ARM LENGTH*
ELBOW-WRIST LENGTH	ARM LENGTH*

* ARM LENGTH= (ACROMION-RADIALE) + (RADIALE-STYLION) + (HAND LENGTH).

COLUMN NUMBERS

```
          10        20        30        40        50        60
xxxxxx----+----|----+----|----+----|----+----|----+----|----+----|

00100 12 BOTH   SAMPLE REGRESSION MEMBER
00200
00300     THIS ANTHROPOMETRIC  MEMBER IS BASED ON THE ANTHROPOMETRY  OF
00400 AIR FORCE MAINTENANCE  TECHNICIANS.  THE BASIS FOR MALE ANTHROPOMETRY
00500 WAS THE 1965 SURVEY OF AIR FORCE MALE PERSONNEL, WHICH WAS EDITED
00600 ACCORDING TO AFR 160-43.  IN ADDITION, ONLY THOSE PERSONNEL AT THE
00700 MASTER SERGEANT LEVEL OR BELOW WERE INCLUDED, SINCE THOSE OF HIGHER
00800 RANK WOULD NOT TYPICALLY BE PERFORMING MAINTENANCE.
00900     THE BASIS OF THE FEMALE ANTHROPOMETRY  WAS THE 1968 SURVEY OF
01000 AIR FORCE WOMEN, WHICH WAS EDITED USING THE SAME STANDARDS  AS THE
01100 MALES.
01200     BOTH SETS OF DATA WERE ADJUSTED, USING A CALCULATED  GROWTH
01300 FACTOR, BASED ON DATA FROM THE AIR FORCE'S ESTABLISHING  PHYSICAL
01310 CRITERIA FOR ASSIGNING PERSONNEL TO AIR FORCE JOBS STUDY.
01400
01500 STATURE                     MALE
01600    63.2       64.8       69.1       73.8       76.1
01700 STATURE                     FEMALE
01800    59.2       60.4       64.3       68.5       70.3
01900 WEIGHT                      MALE
02000   110.6      122.9      154.7      194.7      207.4
02100 WEIGHT                      FEMALE
02200    96.2      103.8      126.8      146.6      157.4
02300                               .
02400                               .
02500                               .
```

Figure E.2: Example Input for Creating a New Anthropometric Member.

Member will contain both male and female data, and that the Regression Member to be used for calculating data for the 10 additional variables is 'SAMPLE REGRESSION MEMBER.'

Lines #200 through #1400 contain comments on the methods used to generate this set of data. These comments are stored directly in the database, and will be printed out whenever a REPORT control statement is encountered.

The remainder of the data set consists of data for each of the five base variables used in defining the man-model. Lines #1500 & #1600 contain the percentile data for stature of the male portion of the population, in order of increasing percentile. Lines #1700 and 1800 contain the percentile data for stature of the female portion of the population. The remainder of the data set follows the same format, until data for all five variables have been defined for both genders.

E.3.3 Regression Data Input Format

Regression Members contain the data necessary to "flesh out" the man-model anthropometry. This type of member defines the regression equations for calculating dependent variable values.

The first record contains general information for the regression member.

- NUMCMT GENDR

FORMAT(I2,1X,A6)

NUMCMT- Number of records used for describing the origins of this member. This space can be used for historical recording of the location of the original data, as well as any editing procedures on it.

GENDR - Gender indicator
= 'NONE' , if not gender-specific.
= 'MALE' , if male population.
= 'FEMALE', if female population.
= 'BOTH' , if population is both male and female.

The next NUMCMT records are used to input the historical comments. Each record is formatted as

- <u>COMENT</u>

FORMAT(A72)

COMENT- Informational text.

A regression member contains the data needed to calculate the dependent variables from the input set of independent variables. These calculations are usually performed as linear regressions, where the variable to be calculated, say v_{dep}, is expressed as a linear function

$$v_{dep} = a_1 * v_{ind} + b_1,$$

where v_{ind} is one of the five base variables; and a_1 and b_1 are the regression coefficients. Note that this equation is easily extended to any number of independent variables. Table I also shows which combinations of the five variables are used to calculate each of the additional ten needed. Note also that more than one anthropometric member can reference a single regression member.

- <u>VARNAM GENDR</u>

FORMAT(A20,1X,A6)

This record defines the name of the variable for which a regression equation is being input. The variable name must be

input exactly as seen in table I. The next field, which begins in column 22, specifies the gender which the data describes. The gender need be specified only when the member is to contain both male and female data. The next record defines the actual regression equation for calculating the variable specified above. The regression coefficients are input in the same order they are listed in Table E.1.

- XCEPT, REGCF1, REGCF

  FORMAT(3(F10.4,1X))

  XCEPT - The intercept term for the regression equation.

  REGCF1 - The regression coefficient for the first regressor.

  REGCF2 - The regression coefficient for the second regressor (if needed).

The regression data must be input for each of the ten variables listed in Table I. In addition, if a particular Regression Member contains both male and female data (GENDR= 'BOTH', each variable must be input twice-- once for each gender.

E.3.4 Example Regression Member Addition

Figure E.3 shows an example of the format used to input data for a new Regression Member. The first line (#100) specifies that 19 lines of comments follow the first record, and that the new Regression Member will contain equations for both males and females. The next 19 records (lines #200 through #2000) contain the historical comment data.

The remainder of the data set is used to define the regression equations needed to calculate the 10 additional variables, for both male and females. The first equation entered (lines #2100 & #2200) provides the coefficients for calculating Sitting Height for males as a function of Stature (see Table E.1):

COLUMN NUMBERS

```
       10        20        30        40        50        60
xxxxxx----+----|----+----|----+----|----+----|----+----|----+----|

19 BOTH

    THIS REGRESSION MEMBER IS BASED ON THE ANTHROPOMETRY OF
AIR FORCE MAINTENANCE TECHNICIANS.  THE BASIS FOR MALE ANTHROPOMETRY
WAS THE 1965 SURVEY OF AIR FORCE MALE PERSONNEL, WHICH WAS EDITED
ACCORDING TO AFR 160-43.  IN ADDITION, ONLY THOSE PERSONNEL AT THE
MASTER SERGEANT LEVEL OR BELOW WERE INCLUDED, SINCE THOSE OF HIGHER
RANK WOULD NOT TYPICALLY BE PERFORMING MAINTENANCE.
    THE BASIS OF THE FEMALE ANTHROPOMETRY WAS THE 1968 SURVEY OF
AIR FORCE WOMEN, WHICH WAS EDITED USING THE SAME STANDARDS AS THE
MALES.
    BOTH SETS OF DATA WERE ADJUSTED, USING A CALCULATED GROWTH
FACTOR, BASED ON DATA FROM THE AIR FORCE'S ESTABLISHING PHYSICAL
CRITERIA FOR ASSIGNING PERSONNEL TO AIR FORCE JOBS STUDY.
    FOR THE MALE POPULATION, THE REGRESSION EQUATIONS CALCULATED
HERE ARE ALL BASED ON THE EDITED 1965 SURVEY.  FOR THE FEMALE
POPULATION, ALL EXCEPT ONE OF THE EQUATIONS ARE BASED ON THE
1968 SURVEY.  KNEE HEIGHT/SITTING WAS NOT AVAILABLE IN THE '68
SURVEY, SO REGRESSION EQUATIONS FOR THAT VARIABLE ARE BASED ON
SIMILARLY EDITED DATA FROM THE 1977 SURVEY OF ARMY WOMEN.

SITTING HEIGHT        MALE
    8.7153      0.3956
BIACROMIAL BREADTH    MALE
    9.1140      0.0638      0.0140
BUTTOCK-KNEE LENGTH   FEMALE
    3.9225      0.2397      0.0267
                .
                .
                .
```

Figure E.3: Example Input for Creating a new Regression Member.

SITTING HEIGHT= 8.7153 + (.3956)*(STATURE).

The next two records (lines #2300 and #2400) define male Biacromial Breadth as a function of Stature and Weight (see Table E.1):

BIACROMIAL BREADTH= 9.1140 + (.0638)*(STATURE) + (.0140)*(WEIGHT

Finally, the last two records shown in Figure E.3 define female Buttock-Knee Length as a function of Stature and Weight:

BUTTOCK-KNEE LENGTH= 3.9225 + (.2397)*(STATURE) + (.0267)*(WEIGHT).

The remainder of the data set follows the same format, defining the regression equations for each of the 10 additional variables, for each gender.

APPENDIX F

TOOL DATABASE MAINTENANCE PROGRAM (TOLMNT)

APPENDIX F

TOOL DATABASE MAINTENANCE PROGRAM (TOLMNT)

The Air Force design philosophy is to design systems that can be maintained with standard hand tools. Due to performance and space considerations, it is sometimes required that special tools be used for some applications. Also, there are cases where a standard tool is required for a specific task, which is not included in the CREW CHIEF tool box. To provide the CREW CHIEF users the capability to make tool analyses with special tools, or standard tools not included in the tool box, this program has been developed to allow the user to add such tools to the tool box.

There are several basic requirements for adding a tool to the tool box. Characteristics of the tool which must be defined include:

Bulk and shape of the tool (tool enfleshment)
Grip type used for the tool
Hand(s) used to grip the tool
Point where the tool is gripped
How the tool is used
Parameters of the required space for the working envelope
and interference checking cylinder dimensions).

Two files are required, the drawing file establishing the tool enfleshment, and the Tool Maintenance Control file. The tool maintenance control file is the user's input vehicle for intangible characteristics such as, how the tool may be held, how it is used, and clearances parameters for checking interference.

CREATING A TOOL MODEL

- Tool Enfleshment

The tool enfleshment is designed on the host CADAM system as a CADAM Finite Element model (FEM), or as surfaces which are converted to FEM using the CADAM-supplied Access function "MESH". Once the tool is represented as a CADAM FEM drawing, the user may need to create additional mesh points for use as input for the Tool Maintenance Control file.

After a complete FEM representation is created, the user converts this drawing to a NASTRAN file using the CADAM supplied conversion programs. The first jobstep in the sample JCL provided with the distribution tape creates the mesh file. The second jobstep in the sample JCL provided to the user creates the NASTRAN file. The final jobstep in the tool creation job uses the NASTRAN file output from the MFTN program as input (for FORTRAN unit 10).

- Tool Maintenance Control File

Exterior bulk shape (tool enfleshment) do not determine all the information necessary to accurately model a tool. Many intangible characteristics, such as, how the tool may be held, or how it is used, cannot be determined from a simple FEM model. Such characteristics must be input by the user, and are done so through the Tool Maintenance Control file.

The Tool Maintenance Control file is input through FORTRAN file 10 in the third jobstep in the sample JCL. The input is in card-image format, and is described below.

A. <u>TOOL TYPE</u> - Indicates the Type of the tool being added to the tool database. Under the current version of the tool Database Maintenance program users can only add

"MAIN" type tools. The only value for TOOL TYPE is:

1 - Main Type

B. TOOL CLASS - Indicates the CLASS of the tool being added. For this version of the program users may only tools in the "USER DEFINED" class. The only value for TOOL CLASS is:

8 - User Defined Class

C. MODEL NAME - Any 28 alphanumeric string describing the tool name.

D. EXTENSIONS FLAG - This flag defines whether or not extensions are to be included as accessories for the new tool. When the flag is set to include extensions, all the existing models of extensions (2" through 10") are associated with the new tool. Possible values are:

Y - Include extensions as accessories

N - No extensions as accessories

E. SOCKETS FLAG - This flag defined whether or not sockets are to be included as accessories for the new tool. When the flag is set to include sockets, all existing models of sockets are available for use with the tool. Possible values are:

Y - Include sockets as accessories

N - No sockets as accessories

F. RIGID GRIP FLAG - This defines whether or not the tool can rotate in the hand. Non-rigid grip allows the tool handle to rotate in the hand as it is commonly used, such as when using a ratchet wrench. Rigid grips do

not allow the tool handle to rotate in the hand as it is commonly used, such as when using pliers. Possible values are:

0 - Non-rigid grip type tools

1 - Rigid grip type tools

G. <u>SECOND HAND REACH TYPE</u> - Defines how the second hand may reach and be placed on the tool. The possible values are:

1 - With the palm flat against the tool with the fingers curled around the tool head.

2 - With the palm flush against the tool surface and the hand extended

3 - The second hand may grasp a section of the tool as if it were a handle

H. <u>HAND GRIPS PERMITTED</u> - A tool may be held in one of three initial orientations in the hand (Figure F.1). The REGULAR grip has the point of application for the tool above the thumb, and the tool handle perpendicular to the hand. The REVERSE grip has the point of application for the tool below the Metacarpal V, and the tool handle perpendicular to the hand. The ALTERNATE grip positions the tool handle parallel to the hand. The possible values are:

1 - Regular

2 - Reverse

3 - Alternate

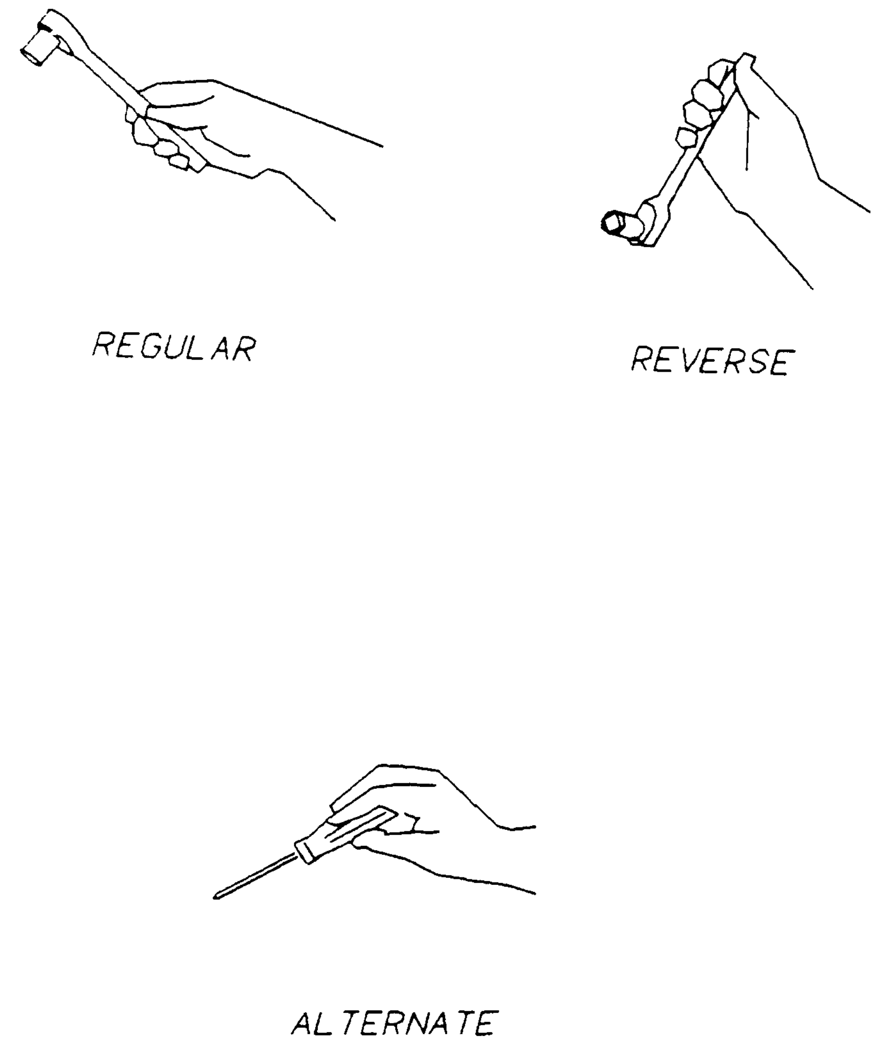


Figure F.1. Hand Grip Types

4 - Regular and Reverse

5 - Regular and Alternate

6 - Reverse and Alternate

7 - Regular, Reverse, and Alternate

I. HAND HOLDING TOOL - defines the hand that is used to hold the tool. Possible values are:

0 - Non-reachable

1 - Right hand only

2 - Left hand only

3 - Both hands

4 - Right hand, or Left hand

5 - Right hand, Left hand, or Both hands

J. HAND ATTACH POINT - The tool may attach to the hand at either the grip center or functional grip center location (Figure F.2). Possible values are:

1 - Grip center

2 - Functional grip center

K. HANDLE RADIUS - A real number describing the radius of the handle.

L. CYLINDER HEIGHT - A real number describing the height of the cylinder used to exclude any geometry inside the cylinder when calculating interference.

Figure F.2. Grip Center and Functional Grip Center Locations

M. <u>CYLINDER RADIUS</u> - A real number describing the radius of the cylinder used to exclude any geometry inside the cylinder when calculating interference.

After the user drawing is converted into a mesh file using the CADAM provided utility (CTFM), all nodes and triangles in the user drawing are assumed to be integral members of the mesh model describing the tool. they can be referred to directly by specifying a node number or a triangle number. The remaining values input by the user make reference to the node identification number used to define the following information.

N. <u>ATTACH NODE OF THE TOOL</u> - Node that attaches the tool to the work place.

O. <u>ATTACH DIRECTION NODE</u> - Node that defines the attach direction of the tool.

P. <u>FIRST NODE PRIMARY HAND CENTERLINE</u> - Node that defined the beginning of the centerline of the handle grasped by the primary hand.

Q. <u>SECOND NODE PRIMARY HAND CENTERLINE</u> - Node that defines the end of the centerline of the handle grasped by the primary hand.

R. <u>FIRST NODE SECONDARY HAND CENTERLINE</u> - Node that defines the beginning of the centerline of the handle grasped by the secondary hand.

S. <u>SECOND NODE SECONDARY HAND CENTERLINE</u> - Node that defines the end of the centerline of the handle grasped by the secondary hand.

T. <u>FIRST NODE MESH ELEMENT</u> - Node that defines the mesh element against which the secondary hand may be placed.

U. <u>SECOND NODE MESH ELEMENT</u> - Node that defines the mesh hand element against which the secondary may be placed.

V. <u>THIRD NODE MESH ELEMENT</u> - Node defining the mesh element against which the secondary hand may be placed.

Entries N through V are required except in the following cases.

1. The definition of centerline for the secondary hand or mesh element for the secondary hand are only needed if the hand holding the tool includes both hands (i.e., only when HAND HOLDING TOOL value is set at **3** or **5**).

2. The definition of the centerline for the secondary hand is mutually exclusive with the definition of the mesh element for the secondary hand (i.e., define either right or left, not both). The criteria used to decide which should be defined is as follows:

   a. The centerline for the secondary hand (both beginning and ending nodes) is needed only when the value for HAND HOLDING TOOL is set at **3** or **5**, and the SECOND HAND REACH TYPE value is set at **3**.

   b. The mesh element (all three nodes) is needed only when the value set for HAND HOLDING TOOL is set at **3** or **5**, and the SECOND HAND REACH TYPE value is set different from at **1** or **2**.

Those entries that are not required should be input with a value of **9999**. These values are ignored by the maintenance program and are not subject to validation. Notice that the first 24 characters in each line of the user defined input are used for documentation purposes. The maintenance program ignores these characters. Although values in these

columns are not required, we recommend using meaningful character strings describing the contents and format of each line as shown in Figure F.3.

RUNNING THE TOOL MAINTENANCE PROGRAM

Once the drawing of the tool to be added is completed, and all the user defined data is created, the user is ready to run the maintenance program by submitting the JCL named 'CREW.CHIEF.PRODJCL(MAKETOOL)'. This JCL takes the user drawing and converts it into a NASTRAN file. By reading both the NASTRAN file and the user defined information, the tool is created in the tool database.

The user needs to modify line number 36 to include the name of the drawing being used to create the tool. Once this change has been made, the user can submit the above JCL and the tool will be created. If errors are found in the user's input data, the maintenance program will print an error message and stop execution before the database has been updated, thereby not corrupting the database. Once the errors are corrected, the user can re-submit the maintenance program until it executes successfully.

TYPE:	1
CLASS:	8
MODEL NAME:	USER OPEN END
EXTENSIONS:	Y
SOCKETS:	Y
RIGID GRIP FLAG:	0
SECOND HAND REACH:	1
HAND GRIPS PERMITTED:	4
HAND HOLDING TOOL:	4
HAND ATTACH POINT:	2
HANDLE RADIUS:	0.85
CYLINDER HEIGHT:	1.00
CYLINDER RADIUS:	1.00
ATTACH NODE:	1
ATTACH DIRECTION:	2
NODE 1 CT LINE(HAND1):	3
NODE 2 CT LINE(HAND1):	4
NODE 1 CT LINE(HAND2):	5
NODE 2 CT LINE(HAND2):	6
NODE 1 MESH EL(HAND2):	7
NODE 2 MESH EL(HAND2):	8
NODE 3 MESH EL(HAND2):	9

Figure F.3. Sample of Contents and Format of Character String

APPENDICES' REFERENCES

A.1 "Human Engineering Design Criteria for Military Systems, Equipment, and Facilities," MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

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